Cetaceans and Seabirds
of Ireland's Atlantic Margin

Volume I

SEABIRD DISTRIBUTION, DENSITY & ABUNDANCE

CMRC

Irish Petroleum Infrastructure Programme (PIP)

Cetaceans and Seabirds of Ireland's Atlantic Margin

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SEABIRD DISTRIBUTION, DENSITY & ABUNDANCE

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SUMMARY

The waters surrounding the island of Ireland are home to a wide variety of seabird and cetacean (i.e. whale and dolphin) species. This report presents detailed findings from research conducted under the auspices of the Petroleum Infrastructure Programme set up by Ireland's then Department of the Marine and Natural Resources in 1997. The *Cetaceans & Seabirds at Sea* research programme, which commenced in 1999, has now been completed and the findings are presented in three volumes under the title "Cetaceans and Seabirds of Ireland's Atlantic Margin".

Volume I: Distribution, density & relative abundance of seabirds along Ireland's Atlantic Margin.

The primary objectives of the seabird research reported on in this volume are as follows:

> 1. **To establish reliable baseline information on the relative abundance of seabirds in the waters of Ireland's Atlantic Margin throughout the year;**
>
> 2. **To identify major areas of concentration for seabirds in these waters and evaluate seasonal trends in distribution;**
>
> 3. **To estimate, where possible, the density of key seabird species inhabiting the waters of Ireland's Atlantic Margin;**
>
> 4. **To provide high quality independent scientific information essential for conservation and management purposes.**

- The report presents data obtained on *Cetaceans & Seabirds at Sea* strip-transect surveys combined with data collected from incidental sightings;
- A total of 442 survey-days at sea were achieved between 1st July 1999 and 30th September 2001;
- The survey spanned all seasons although the numbers of ship-based transects conducted in December and January were lower than in other months;
- The overall results have revealed areas of relatively high species richness and high density for seabird species in the deeper Atlantic waters off the southwest, west and northwest coasts of Ireland;
- The Hatton Bank and Hatton-Rockall Basin also appear to be of importance to migratory species, and together with the Rockall Bank may be of importance to those species that winter offshore, such as the Atlantic Puffin (*Fratercula arctica*), and to non-breeding and juvenile birds during the breeding season (e.g. Manx Shearwater [*Puffinus puffinus*]);
- Thirty-seven seabird species were recorded, including important rarely-sighted species such as Brünnich's Guillemot (*Uria lomvia*) and Soft-plumaged Petrel (*Pterodroma* sp.), and key migratory species, such as the Black-legged Kittiwake (*Rissa tridactyla*), Northern Gannet (*Sula bassana*) and the Lesser Black-backed Gull (*Larus fuscus*);
- Interesting data was also gathered on the seasonal migrations of southern-breeding shearwater species (i.e. Sooty Shearwater [*Puffinus griseus*] and Great Shearwater [*P. gravis*]), and of large and small skua species over the deeper waters off the west coast of Ireland;
- Biogeographically significant findings were obtained during surveys in waters overlying the Hatton Bank and Rockall Bank, where species such as the Brünnich's Guillemot, Little

Auk (*Alle alle*) and Sabine's Gull (*Xema sabini*) were found in small numbers in May and June, considerably further south than their known breeding grounds;

- A deep-water south/southwest migration of Lesser Black–backed Gulls was identified during the *SIAR* survey of 2000. This movement possibly involved breeding populations from Iceland and Scandinavia;
- While European Storm-petrels (*Hydrobates pelagicus*) were recorded relatively frequently, they were not as abundant as might have been predicted by their breeding population sizes along the west coast of Ireland. This anomaly may relate to the difficulties of detecting this and other small petrel species at sea;
- There were also fewer sightings of Manx Shearwater than might have been expected. This pelagic species is believed to breed in greater numbers along the west coast of Ireland than the Northern Fulmar (*Fulmarus glacialis*), but this was not reflected in the offshore surveys;
- Twenty coastal and inshore bird species and 15 terrestrial bird species were also recorded.

The results gathered are discussed in their methodological and biological contexts and conclusions are made on the basis of these findings, including proposals for future areas of work, both thematic and geographic, in the Irish Atlantic Margin region.

INTRODUCTION

BACKGROUND

Ireland's offshore territory has been surveyed and explored to establish the extent and commercial viability of its hydrocarbon resources since the early 1970s. During the 1990s this marine research and the associated drilling operations have been largely focused on government-granted licence blocks located along the Irish Atlantic Margin (Fig. 1.0). To date, significant finds of gas have been identified and earmarked for exploitation in the Corrib field off the northwest coast of County Mayo (Plate 1) and the Seven Heads field in the Celtic Sea south of County Cork. However, it is widely acknowledged that little is known about this extensive offshore region from many physical and biological perspectives.

Plate 1. Drilling rig off the west coast of Ireland.

Among the diverse marine fauna which may be detrimentally affected by such exploration and its associated developments are those at the top of marine food webs including seabirds and cetaceans. While the immediate impact of oil pollution on seabirds and marine mammals has been well documented in a number of cases (e.g. *Exxon Valdez*, *Braer* and *Prestige* oil spills: Bodkin *et al.*, 2002; Camphuysen *et al.*, 2002; Heubeck, 2003; McCrary *et al.*, 2003), there are many impacts from hydrocarbon exploration/exploitation and other human activities which may influence the effective conservation and sustainability of Ireland's marine biological resources (Cramp *et al.*, 1974; Briggs *et al.*, 1997; Murray & Simmonds, 1998; DMNR, 2000; Reid *et al.*, 2001; Golet *et al.*, 2002; Hoelzel, 2002; Hampton *et al.*, 2003a; Hampton *et al.*, 2003b).

In contrast with most land birds, seabirds have a very low annual reproductive output (1-3 eggs), which is balanced by relatively high annual adult survival rates (90+%). Because of these exceptional life history traits, seabirds are acutely vulnerable to environmental perturbations including those resulting from pollution and, over the longer term, climate change. Any increase in adult mortality rates is likely to be additive, with the result that the population may be propelled into a decline from which it is unable to recover (Lloyd *et al.*, 1991; Newton, 1998).

To date, hydrocarbon exploration in Ireland's offshore waters has occurred in an environment which has seen relatively little biological research. Although dedicated surveys of seabirds at sea in the northeast Atlantic began in earnest in 1978 (Tasker *et al.*, 1984) and considerable research has been undertaken in these waters since then (e.g. Evans, 1981; Bourne, 1986; Pollock, 1994; Pollock *et al.*, 1997; Pollock *et al.*, 2000), much of the data gathered in an Irish context have concentrated on inshore, coastal and continental shelf waters, less than 200m deep. Data gathered on cetaceans inhabiting the waters off western Ireland are even more sparse, with few dedicated surveys (i.e. Evans, 1990; Leopold *et al.*, 1992; Gordon *et al.*, 1999) and relatively small-scale coverage throughout Ireland's Atlantic Margin.

Against the backdrop of such limited information, the present study was formulated as part of an overall drive to deliver detailed scientific information on the physical and biological resources of the Irish Atlantic Margin. This study formed a three-year *Cetaceans & Seabirds at Sea* research project undertaken by the Coastal & Marine Resources Centre (CMRC), University College, Cork. The research was performed on behalf of the Rockall Studies Group (RSG) and Porcupine Studies Group (PSG) under the Petroleum Infrastructure Programme (PIP) set up in 1997 by Ireland's Department of the Marine and Natural Resources (Murphy, 2001).

Under the overall *Cetaceans & Seabirds at Sea* project, a number of parallel studies were performed. These consisted of (i) "Seabirds at sea" sighting surveys; (ii) Cetacean sighting surveys, and (iii) Acoustic surveys for cetaceans. These studies are presented in three volumes under the title "Cetaceans and Seabirds of Ireland's Atlantic Margin" and Volume I, presented here, is broadly concerned with data collected on ship-based sighting surveys for seabirds.

STUDY AREA

The primary study area for the project consisted of the offshore waters to the southwest and west of Ireland (Fig. 1.0), commonly termed "Ireland's Atlantic Margin" (Naylor *et al.*, 1999). This area stretches from the Goban Spur through the Rockall Trough and includes the adjoining Rockall Bank and continental shelf areas including the prominent western "Porcupine Shelf", a bathymetric high that encompasses the relatively shallow Porcupine Bank. Research effort during the study extended into waters north and east of this region (e.g. Irish Sea, Sea of the Hebrides) considering the potential for large-scale seabird migration through the region in space and time.
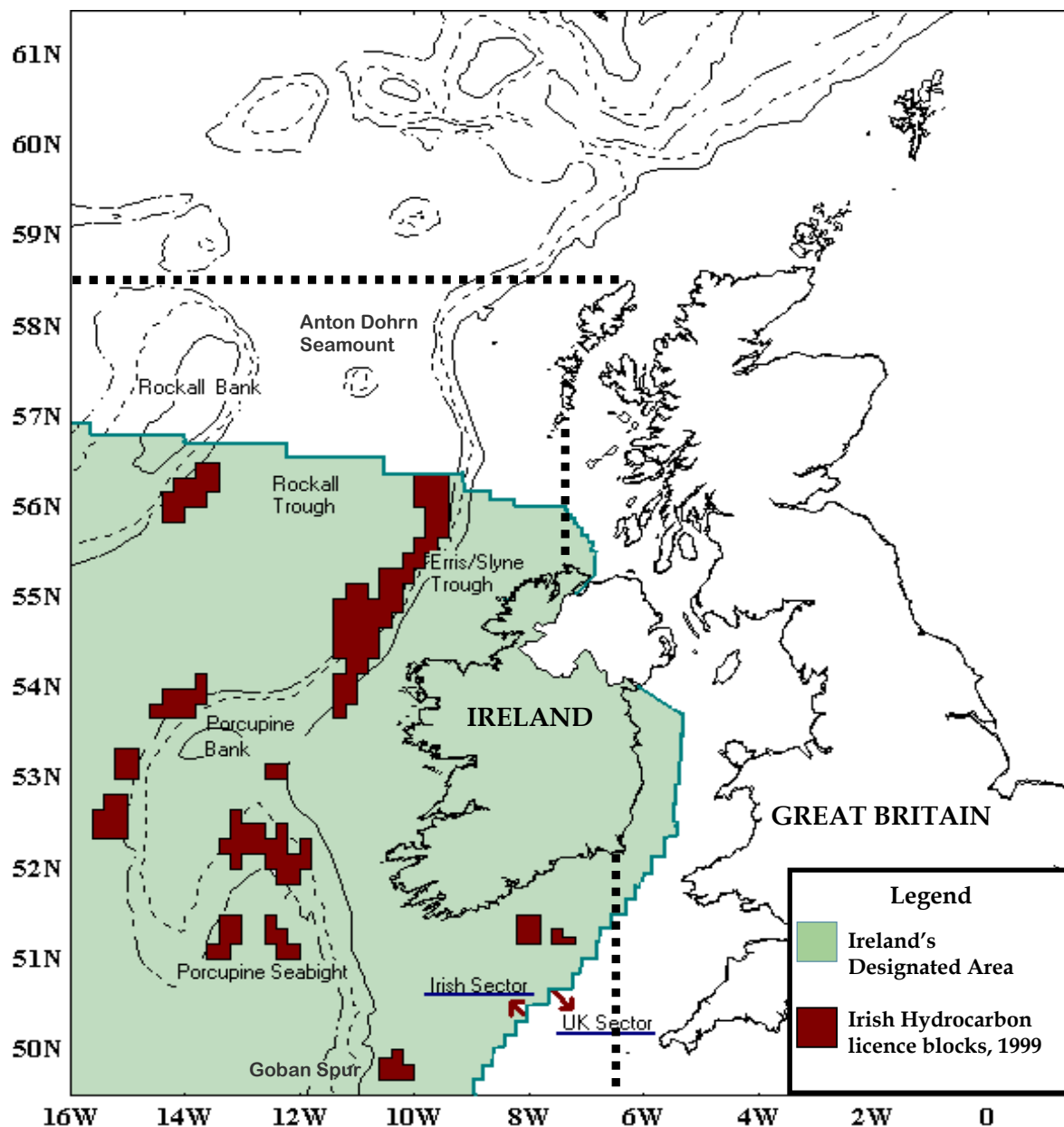

Figure 1.0. Project study area (to left of dotted line ▪ ▪ ▪) showing waters comprising the Republic of Ireland's Offshore Designated Area (shaded) and licence blocks for hydrocarbon exploration held in 1999. [_____ 200m isobath; _ _ _ _ _ _ 500m isobath; ___ __ ___ 1000m isobath.]

DISTRIBUTION, DENSITY & RELATIVE ABUNDANCE OF SEABIRDS ALONG IRELAND'S ATLANTIC MARGIN

INTRODUCTION

Volume I of the *Cetaceans & Seabirds at Sea* final report describes herein the distribution, density and relative abundance of seabirds of Ireland's Atlantic Margin. The Atlantic Margin of Ireland's west coast is characterised by a number of physical, climatic and oceanographic features, which combine to produce one of the most productive areas of the northeast Atlantic Ocean. Consequently, the waters off western and southern Ireland contain internationally-renowned commercial fishing grounds (e.g. Porcupine Bank, Celtic Sea), important nursery and spawning areas for fish and invertebrate species, and areas of concentration for foraging seabirds and other predators (Boelens *et al.*, 1999).

The jagged, exposed and often inaccessible nature of the Irish coastline offers an ideal base for large aggregations of breeding terrestrial bird and seabird species (*see* Hamer *et al.*, 2002). Figure 1.1 highlights the locations of the most important seabird colonies in three regions of the Irish coastline. Prominent ledges on headland and island cliff faces offer certain species, such as Common Guillemots, Black-legged Kittiwakes, Great Cormorants and Northern Fulmars, refuge from mammalian predators. Exposed and hostile rocky islands and sea-stacks, such as Little Skellig (County Kerry) and Bull Rock (County Cork), provide Northern Gannets with a similar form of isolation and protection that would test the hardiest and most agile of predators. Cliff top burrows (for Manx Shearwaters, Atlantic Puffins, storm petrels), sea caves (for European Shags), rocky shorelines (for Black Guillemots), boulder screes (for storm petrels), rock crevices (for Roseate Terns), simple ground scrapes (for Arctic and Common Terns) and sandy or shingle spits (for Little Terns) are other natural habitats exploited by seabirds along the Irish coast during the breeding season (April - August).

In addition to a safe nesting site, the Irish coastline also provides breeding seabirds with another vital requirement for survival: close proximity to a dependable food supply (Cramp *et al.*, 1974). The coastal and offshore waters of Ireland provide local breeding and non-breeding seabirds, together with pelagic and passage migrants (e.g. Great Shearwater, Arctic Skua), with a rich source of nutrition, particularly at those feeding grounds associated with coastal upwellings and frontal systems (Fig. 1.2).

The availability and distribution of prey are considered to be the most important factors driving seabird distribution and abundance (Skov *et al.*, 1995; Begg & Reid, 1997; Ollason *et al.*, 1997), particularly around colonies during breeding season (Boelens *et al.*, 1999). Although some seabird species are able to adapt to fluctuations in food availability (Montevecchi *et al.*, 1988), it has been shown that seabird survival, breeding success and chick growth are closely correlated to food availability (Coulson & Thomas, 1985; Cairns, 1987; Croxall & Rotherby, 1991; Hamer & Furness, 1991; Barrett & Krasnov, 1996; Furness & Tasker, 2000). The main prey items of seabirds, including small schooling pelagic fish (e.g. lesser sandeel [*Ammodytes* spp.], herring [*Clupea harengus*], sprat [*Sprattus sprattus*]) and moderately sized pelagic crustaceans and squid, are to be found in the upper- and mid-water column (Coulson & Thomas, 1985; Montevecchi, 1993; Shealer, 2002).

At least 22 seabird species breed regularly along the Irish coastline (Cramp *et al.*, 1974; Lloyd *et al.*, 1991; Mead, 2000). The three coastal regions depicted in Figure 1.1 are used by the UK Joint Nature Conservation Committee's (JNCC) Seabird Colony Register in monitoring seabird populations of the northeast Atlantic.
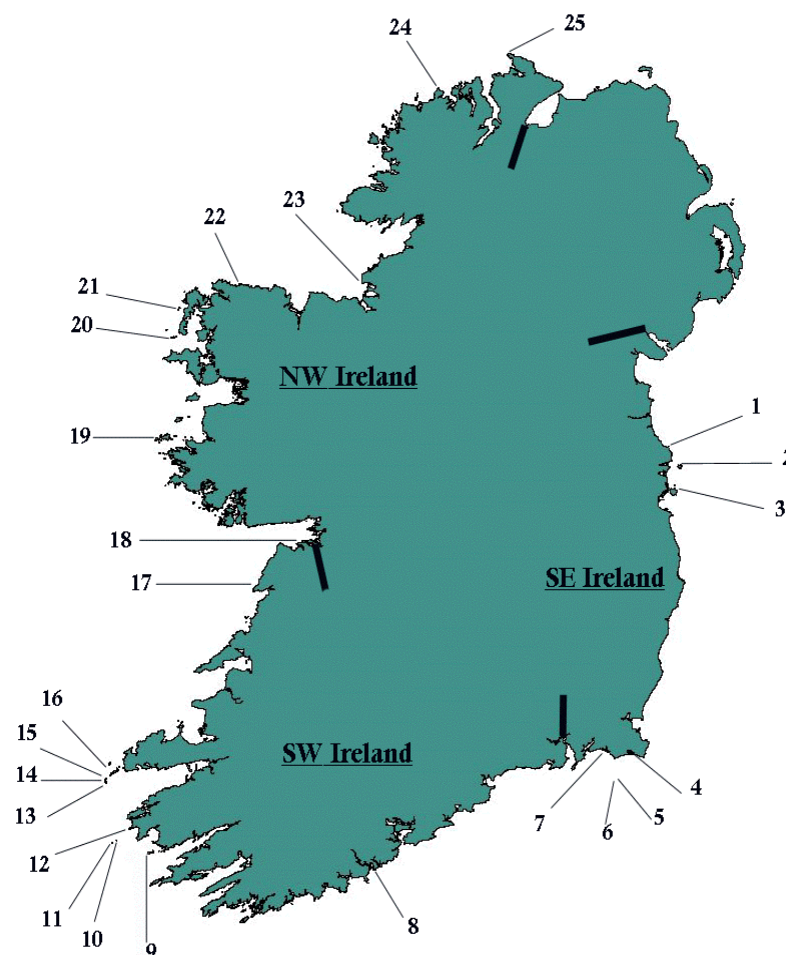
Figure 1.1. The 25 most important seabird colonies (listed in Table 1.0) in the three coastal regions of the Irish coast. (*Adapted from* Boelens *et al.*, 1999).

The highest concentrations of breeding seabirds along the Irish coast are located in the southwest (n=124,626) and southeast (n=109,535) regions, situated close to the rich feeding grounds of the Celtic Sea and the inshore and continental shelf waters to the west and southwest of Ireland (Boelens *et al.*, 1999). Any differences in survey effort, which may have contributed to the relatively low number of breeding seabirds recorded from the northwest region (n=52,330), should be resolved by the forthcoming results of the "Seabird 2000" survey.

Table 1.0 lists the 25 important sites for each region, along with the species for which the sites are noteworthy. The designation of these most important seabird breeding sites is based on the presence of one or more species in numbers greater than 1% of the EU or UK and Irish populations. Northern Gannets, Great Cormorants, European Shags, European Storm-petrels, Sandwich Terns, Roseate Terns, Razorbills, Common Guillemots and Atlantic Puffins are present at one or more sites in numbers higher than either the EU and/or UK and Ireland 1% threshold (Boelens *et al.,* 1999).

The seabird species recorded along Ireland's Atlantic Margin adopt a variety of at-sea feeding methods in an effort to exploit its ever-changing resources (*see* Shealer, 2002). The strategies employed range from the spectacular deep-diving of the Northern Gannet, shallow plunges displayed by terns and gulls, the pursuit-plunging of shearwaters and Northern Fulmars and the pursuit-diving of the auks. Gulls and terns also dip at the ocean's surface while in flight, as do the planktivorous storm petrel species. The scavenging of kleptoparasitic (i.e. pirate) species, such as skuas and large gulls, target the freshly-fished or regurgitated offerings of harassed

Northern Gannets, Black-legged Kittiwakes, terns, auks, shearwaters and, in some cases, other kleptoparasites (Furness, 1987; Olsen & Larsson, 1997). Certain offshore and inshore seabird species, such as Northern Fulmars, Northern Gannet, Great Skuas and gulls, also scavenge fishing discards (Furness, 1987; Dunnet *et al.*, 1990; Pollock, 1994; Camphuysen & Garthe, 1997; Hamer *et al.*, 1997; Oro & Ruiz, 1997; Walter & Becker, 1997; Flore, 1999; Martínez-Abraín *et al.*, 2002).

TABLE 1.0. Important coastal seabird breeding colonies occupied by one or more species exceeding 1% of the EU and/or UK and Ireland population. Numbers refer to site locations in Figure 1.1. (*Adapted from Boelens et al.*, 1999).

Coastal Region	No.	Site	Species Exceeding 1% Threshold	
			EU	UK & Ireland
SE Ireland	1	Rockabill	RT	
	2	Lambay Island	C, GU	S
	3	Ireland's Eye		C
	4	Lady's Island Lake	RT, ST	
	5	Little Saltee		C
	6	Great Saltee		GU, R
	7	Keeragh Island		C
SW Ireland	8	Sovereign Island		C
	9	Scarriff Island		SP
	10	Little Skellig	G	SP
	11	Skellig Michael		SP
	12	Puffin Island		SP, P?
	13	Inishvickillane	SP	
	14	Inishnabro		SP
	15	Inishtearaght	SP	
	16	Inishtooskert	SP	
	17	Cliffs of Moher		GU, R
	18	Deer Island		C
NW Ireland	19	Inishark		SP
	20	Duvillaun Islands		C
	21	Inishglora	SP	
	22	Illaunmaster		SP
	23	Ardboline		C
	24	Horn Head		R
	25	Inishtrahull		S

G = Northern Gannet, C = Great Cormorant, S = European Shag, SP = European Storm-petrel, ST = Sandwich Tern, RT = Roseate Tern, R = Razorbill, GU = Common Guillemot, P = Atlantic Puffin.

Although the North Atlantic Ocean and its adjacent seas contain a myriad of species that may be exploited, the distribution of prey is never uniform in space or time and dynamic physical and oceanographic features prevail to maintain this characteristically heterogeneous environment. Such features occur on a range of scales, from large-scale processes (e.g. oceanic circulation routes) to smaller-scale local systems (e.g. tidal races) (Hunt & Schneider, 1987). Some of these processes carry the potential to concentrate prey in areas of high productivity (Raine *et al.*, 1990), thereby making them more available to predators (Haney & McGillivary, 1985).

The natural features, environmental conditions and resource-utilisation occurring along much of Ireland's Atlantic Margin were reviewed in detail by the Marine Institute (Boelens *et al.*, 1999). Characteristics which may play an important role in the distribution and abundance of prey species and seabirds in the region were documented by Boelens *et al.* (1999) and are outlined briefly here. The waters to the west of Ireland are influenced by a significant northeast-heading component of the Gulf Stream, known as the North Atlantic current or North Atlantic

Drift (Fig. 1.2). The complex hydrography resulting from the meeting of this warm oceanic current and the western European continental shelf along Ireland's Atlantic Margin is not fully known. Yet the literature generally describes the greater component of oceanic current moving northwards in the deep Atlantic waters of the Rockall Trough. At its southeastern and northwestern margins, a system of weaker large-scale eddies are established along the relatively shallow Rockall Bank and continental shelf areas off western Ireland (Wood *et al.*, 1996). To the north of the basin-like Porcupine Seabight, the oceanic and inshore shelf currents, separated year-round by the haline Irish Shelf Front (Huang *et al.*, 1991), tend toward the northeast. To the south, along the western margin of the Celtic Sea, there are both southward and northward current components in operation (Boelens *et al.*, 1999). Regional eddy systems also occur in Irish shelf waters of the Porcupine Shelf and central Celtic Sea (Pingree & Le Cann, 1989).
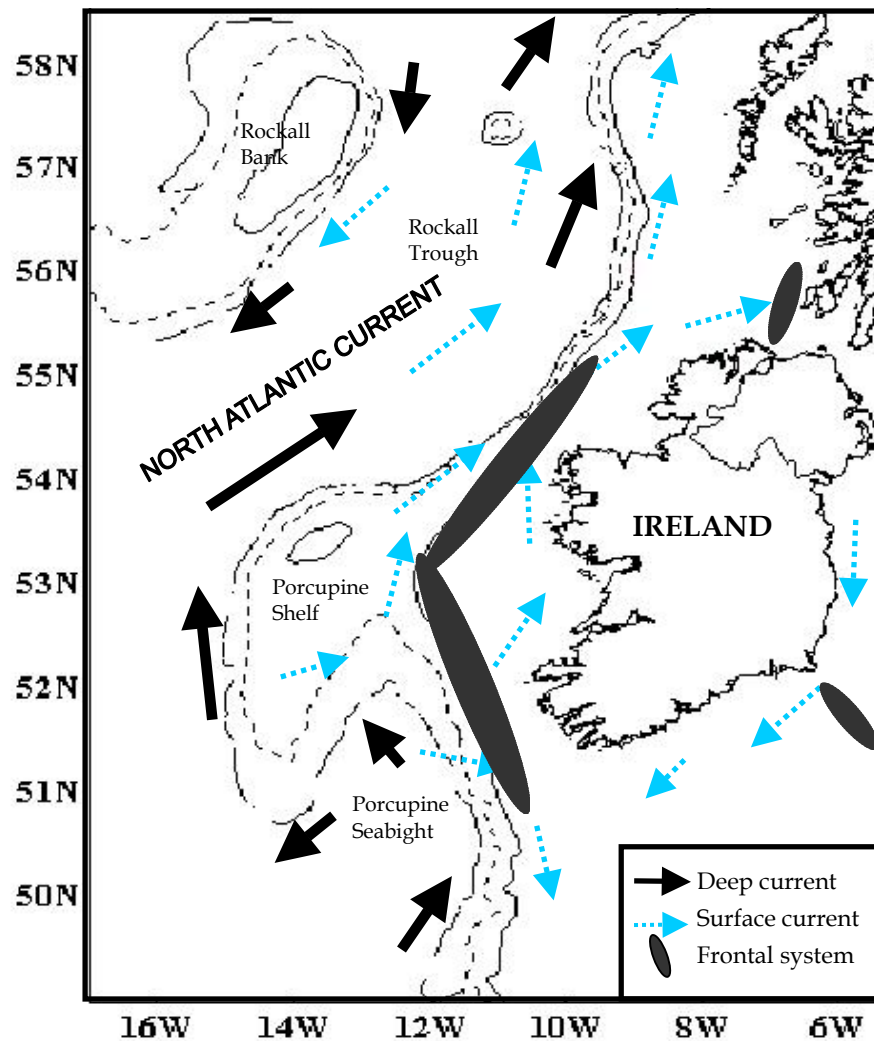

Figure 1.2. General representation of deep water and surface currents occurring in Ireland's Atlantic Margin, including well-known frontal systems operating in the region. (*Adapted from* Pollock *et al.,* 1997; Vermeulen, 1997; Boelens *et al.*, 1999).

As a result of the complex interactions between these shelf and oceanic water bodies, seasonal climatic conditions, sea temperature and salinity variations, and regional upwellings of deep, nutrient-rich oceanic water, areas of seasonally high productivity are known to occur along Ireland's Atlantic Margin. These areas see dense concentrations (blooms) of phytoplankton promoted by seasonal light levels and vertical mixing in the water column. Where periodic upwelling or significant terrestrial freshwater input takes place, the influx of nutrient-rich water may maintain locally high productivity levels for a period of weeks or even months. Such

events have been shown to significantly boost local primary production off southwestern Ireland (Raine *et al.*, 1990). Similar episodic upwellings are likely to occur off the west and northwest coasts, although few data are presently available (Boelens *et al.*, 1999).

The significance for marine predators of spatial and temporal patterns in primary production is perhaps self-evident. In the case of storm petrel species, for example, populations of their zooplankton prey are directly dependent on phytoplankton availability. However, the distribution and abundance of zooplankton, which form a major link in the food chain between phytoplankton and fish populations, are also influenced by sea temperature, predation and water currents (Skov *et al.*, 1995). Such factors contribute further to the patchy distribution of food resources for seabirds and other predators.

In keeping with the ecological importance of the Atlantic Margin, there is substantial background evidence identifying this region as an area of high diversity for seabirds. Offshore seabird surveys in western Irish waters have been conducted by observers from the UK Joint Nature Conservation Committee (JNCC) in Scotland. Many authors have identified the threats that water-borne pollution incidents pose to seabird populations, particularly those species that frequently associate with the ocean's surface (e.g. auks, divers, sea-ducks, skuas, Manx Shearwater, European Shag, Great Cormorant) (Cramp *et al.*, 1974; Harris, 1984a; Tasker *et al.*, 1990; Carter *et al.*, 1993; Williams *et al.*, 1994; Thompson *et al.*, 1997; Heubeck, 2000; Mead, 2000; Pollock *et al.*, 2000). The JNCC's Seabirds at Sea Team identified the need (i) to map the offshore distribution of seabirds (Stone *et al.*, 1995; Pollock *et al.*, 1997), and (ii) to describe the locations of vulnerable concentrations of marine birds west of Britain (Tasker *et al.*, 1990; Webb *et al.*, 1995) and in the North Sea (Carter *et al.*, 1993). The JNCC, in collaboration with the Royal Society for the Protection of Birds (RSPB) and the Shetland Oil Terminal Environmental Advisory Group (SOTEAG), also conducted surveys of seabird breeding colonies throughout Britain and Ireland (Walsh *et al.*, 1993; Walsh *et al.*, 1994; Thompson *et al.*, 1996; Thompson *et al.*, 1997). More recently, the JNCC's Seabirds at Sea team joined forces with BirdWatch Ireland and the UK Seabird Group to coordinate a major national survey (i.e. Seabird 2000). Outside of what the JNCC and its collaborators have accomplished, research concerning Irish seabird populations also appears to concentrate on inshore and coastal aggregations and breeding colonies (Lloyd, 1981; Hudson, 1982; McGrath & Walsh, 1985; Brazier & Merne, 1989; McGrath & Walsh, 1996; Creme *et al.*, 1997; Merne & Madden, 1999; Ratcliffe *et al.*, 2000; Newton & Mitchell, 2001; Lysaght, 2002; Merne & Madden, 2002) together with coastal seawatch records (Gibbs, 1969; Pettitt, 1969; McAdams *et al.*, 1999; McAdams *et al.*, 2000; Milne *et al.*, 2002; O'Clery, 2002; Milne, 2003).

The Republic of Ireland is legally required under the EC Birds Directive (1979) to conserve vulnerable and other migratory birds and their habitats (Way *et al.*, 1993). As a signatory state to the Ramsar Convention (1971), the Irish Government is also committed to promoting the conservation and wise use of wetlands, primarily to provide habitats for wetland birds (Way *et al.*, 1993). In spite of these measures, and other conservation-oriented declarations under the Bonn Convention on Migratory Species (1983), the Berne Convention on Conservation of European Wildlife and Natural Habitats (1979), the OSPAR Convention for the Protection of the Marine Environment of the northeast Atlantic (1992) and the EU Habitats Directive on the Conservation of Natural Habitats and of Fauna and Flora (1992), quantitative data on the natural history, population status and distribution of seabird species in Irish waters have been relatively deficient.

The present study has sought to address many of the above concerns by conducting broad-scale seabird research along the entire Irish Atlantic Margin to its westernmost limits, favouring survey effort outside those areas covered in previous studies in order to break new ground and maximise the opportunity presented.

METHODS

Between July 1999 and September 2001 trained scientific observers from the CMRC'S *Cetaceans & Seabirds at Sea* team conducted ship-based surveys throughout the Irish Atlantic Margin study area. Surveys were conducted year-round on "vessels of opportunity" (e.g. international research vessels, naval vessels: Plate 2), which were scheduled to be at sea in the study area for a period of days or weeks, and whose host organisations were able to provide a spare berth for one or more observers. Thanks to friendly collaboration with a wide range of Irish, British and mainland European host organisations operating in the study area, eighteen such survey vessels were used on a total of 36 research cruises (*see* Appendix A).

In order to optimise sea-time and data collection capabilities, sightings of seabirds were recorded on all occasions and in all possible weather conditions using the methods outlined below:

SEABIRD & CETACEAN STRIP-TRANSECT SURVEYS

The primary visual survey method used aboard vessels of opportunity was that outlined by Tasker *et al.* (1984) and Webb & Durinck (1992). Originally designed as a standard method for counting seabirds at sea, the survey technique has been expanded to include cetacean sighting records, since cetaceans are regularly seen in the field by observers conducting ship-based seabird surveys. Often referred to as the "JNCC" or "Seabirds at Sea" method, it has been used for many years throughout western European waters and is a cost-effective and logistically undemanding means of counting seabirds and marine mammals in the open sea. The method generally consists of a strip-transect survey (Buckland *et al.*, 2001) conducted by a single scientific observer who records survey effort, environmental conditions (e.g. glare, water depth, wind strength, swell height), positional data, and sightings of the various species encountered to one side of the vessel's trackline.

In the *Cetaceans & Seabirds at Sea* project, as in other "Seabirds at Sea" surveys, the method required that the host vessel was travelling on a straight course, at a constant speed of 5-15 nautical miles per hour (knots), and in sea conditions no greater than those of Beaufort Force 6. Observers were normally situated on the ship's bridge-wings or on the monkey-island (i.e. above the bridge) at a platform height of ≥ 9-10m, depending on the vessel. Where these general criteria were met, the observer conducted visual scans with the naked eye in a 90° bow-to-beam sector forward of the ship, concentrating on a 300m-wide strip, from which seabird density estimates may be calculated. Water-resistant binoculars (*LEICA* 10x42) were used to confirm features such as species identification, group size and behaviour.

Sighting data collected while on full transect survey effort were used to determine year-round species distribution, in addition to seabird abundance and density estimates, which ultimately contribute to a central European Seabirds at Sea (ESAS) database. During a full survey, three sub-surveys were conducted simultaneously:

a) **Flying Bird Survey:** All flying birds that were observed within a quadrant at the time of a "snap-shot" count were recorded. The quadrant was defined as 300m to the beam and 300m ahead of the ship. Snap-shot frequency was ship-speed dependent such that snap-shots were timed to occur at the moment the ship passed from one quadrant to the next. All data recorded using this method were included in density, relative abundance and distribution analyses. All data concerning flying birds seen outside the snap-shot count but within the 90° survey zone, were used for relative abundance and distribution analyses. Since the presence of the ship might introduce bias in the data, records of flying birds considered to be associated with the survey vessel were considered as invalid data for analysis.

b) **Survey for Birds Associated with the Water:** All birds whose behaviour was considered to be associated with the water (sitting, diving, skimming, feeding, sleeping, etc), and which were observed within a transect 300m abeam and forward to the horizon, were recorded. The same birds were further categorised to one of four different divisions, depending on the perpendicular distance from the observer (Band A: 0-50m; Band B: 51-100m; Band C: 101-200m; Band D: 201-300m). The trained observers approximated the distances by eye. All data recorded using this method were included in density, relative abundance and distribution analyses. All data concerning those birds associated with the water beyond the 300m transect (Band E) were used for relative abundance and distribution analyses.

c) **Cetacean Survey:** Cetaceans were surveyed in the same manner as seabirds associated with the water. In addition, data concerning the angle of the initial sighting from the ship's course, and the approximate distance from the observer were also recorded. Group size, group composition (number of adults, immature animals, calves), sighting cues, surfacing intervals, behaviour (swimming, logging, spy-hopping, breaching, etc) and any associations with birds were also noted (for more detail, *see* Vol. II).

Plate 2.   The Irish Naval Service's flagship, L.E. *Eithne*, which served as an ideal observation platform throughout the study period.

INCIDENTAL SURVEYS

Point-survey methods were employed when "off-effort" during unsuitable weather conditions (e.g. sea conditions greater than Beaufort Force 6, heavy mist, extreme glare), during periods of frequent vessel course and speed fluctuations, when the host ship was stationary, or on rare occasions when an observer was seasick. Such surveys involved the observer performing scans in all directions, using both the naked eye and *LEICA* 10x42 binoculars from a suitable platform height. All data parameters collected on full transect surveys (i.e. species, group size, behaviour, distance from ship, etc) were also recorded during incidental surveys. In addition, environmental conditions and the host vessel activity and position were recorded every 90 minutes or as required (e.g. if the vessel changed course, if wind conditions changed, etc.).

DATA COLLECTION AND ANALYSIS

Seabird sighting data and all associated effort, environmental and positional data were recorded on paper and subsequently coded for entry into a standard computer database system based in Corel Paradox® 9 software. Database coding manuals and technical support were kindly provided by the JNCC in Aberdeen.

Positional and effort-related data gathered during full "Seabirds at Sea" surveys form the basis of effort plots generated using *Dmap for Windows* version 7.0 (Morton, 1998). These are displayed as ¼ International Council for the Exploration of the Sea (ICES) area units, each measuring 15′ latitude x 30′ longitude. These area blocks are the units of coverage used by the JNCC and other international research groups as a standard means of displaying survey effort and seabird density, facilitating the comparison of international research results.

1. FULL SURVEY EFFORT MAPS

Full survey effort area (km²) for each ¼ ICES square is calculated by multiplying the total number of kilometres of trackline surveyed, using the standard JNCC full survey method, by 0.3 to account for the 300m transect strip-width.

2. CORRECTION FACTORS

The visibility of those seabirds associated with the ocean's surface (e.g. sitting, bathing, diving, dipping, sleeping, searching, etc.) varies with each species, the distance from ship and the sea state. For those datasets requiring density analysis (below), this variation in "sightability" necessitates the application of a compensating correction factor. These multiplication factors are calculated by comparing the number of each species seen at different distances from the ship. Different correction factors can also be generated to account for differences in sea state. Correction factors are not applied to flying bird data.

The correction factors calculated by Stone *et al.* (1995) and Pollock *et al.* (2000), derived from a relatively large dataset spanning more than ten years of research, were used in preference to those calculated from the smaller *Cetaceans & Seabirds at Sea* dataset generated in the present study. Correction factors were applied only to those commonly encountered species requiring density analysis (Table 1.3). Only those birds recorded in association with the water within the 300m transect strip, required correction since birds associated with the water outside of the 300m transect cannot contribute to density analysis using the method of Tasker *et al.* (1984).

3. DENSITY MAPS

A population density analysis was applied to datasets involving those seabird species that were commonly encountered offshore (*see* Table 1.3). Densities are calculated by dividing the number of birds recorded in transect by the transect area surveyed (i.e. number of birds/km²). Each density value is then multiplied by the appropriate correction factor to obtain the corrected values listed in Table 1.3. Certain coastal species that were recorded in relatively high numbers (e.g. Black-headed Gull, Mew Gull and Herring Gull) are not considered relevant enough, in the context of the present study area, to warrant density analysis. The distribution of these species, together with the other rarely encountered seabird and coastal species listed in Table 1.4, are represented using dot distribution maps (*see below*). Seabirds deemed to be associated with the survey vessel, are not included in density analyses.

4. RELATIVE ABUNDANCE HISTOGRAMS

Where monthly changes in relative abundance are noted, a histogram of monthly/seasonal relative abundances is included to give some indication of the varying importance of the survey area for each month. Seabirds deemed to be associated with the survey vessel are not included in relative abundance analysis. Relative abundances for each species are calculated by dividing the number of birds recorded in each month, both in and out of the 300m transect strip, by the

kilometres travelled during full survey (i.e. number of birds/km). Correction factors are not applicable to relative abundance analysis. The colours selected for each of the monthly histogram columns relates to the seasons defined in Table 1.2. Caution should be employed when comparing the histograms between species, as the highest value of each relative abundance axis can vary.

5. TOTAL SEABIRD RELATIVE ABUNDANCE MAP

To highlight potentially important regions for seabirds throughout the study area, a map depicting the relative abundance of all seabird species listed in Appendix B is included below. Seabirds deemed to be associated with the survey vessel, are not included in relative abundance analyses.

6. *SIAR* RELATIVE ABUNDANCE MAPS

Due to the smaller size of the dataset collected during the three-week *SIAR* survey in July-August 2000 (*see* Vol. II), the distribution of commonly encountered seabird species is represented using relative abundance maps (number of birds/km surveyed). Seabirds deemed to be associated with the survey vessel, are not included in relative abundance analyses.

7. SEABIRD & INSHORE BIRD SPECIES TOTAL DISTRIBUTION MAPS

The total number of seabird species (listed in Appendix B) and inshore bird species (listed in Appendix C) recorded in each ¼ ICES square are represented using species total distribution maps. Unlike the density and relative abundance representations, the species-total maps are not effort-related.

8. DOT DISTRIBUTION MAPS

Dot distribution maps represent the distribution of sparsely observed seabirds and coastal/inshore species. Scarce species are defined as those birds with 10 or more records of fewer than 200 birds during the 27-month survey period. The distribution of those coastal gull species that were recorded in relatively high numbers (i.e. Black-headed Gull, Mew Gull and Herring Gull) but not considered relevant enough, in the context of the current study, to warrant density analysis is also represented by dot distribution maps. The colour and location of each dot indicates both the number of birds recorded and the ¼ ICES square in which they were observed. Unlike the density and relative abundance representations, the dot distribution maps are not effort-related.

9. SEABIRD NAME CHANGES

The 2001 report of the ICES Working Group for Seabird Ecology recommended that all seabird researchers should employ an internationally standard nomenclature when describing coastal/inshore bird and seabird species. Table 1.1 outlines the former names used in previous *Cetaceans & Seabirds at Sea* reports and the standard name changes relevant to the current study.

TABLE 1.1. Former seabird and coastal/inshore bird names and the associated standard name change.

Former Name	Current Standard Name
Fulmar	Northern Fulmar
Gannet	Northern Gannet
Cormorant	Great Cormorant
Shag	European Shag
Common Scoter	Black Scoter
Oystercatcher	Eurasian Oystercatcher
Knot	Red Knot
Curlew	Eurasian Curlew
Turnstone	Ruddy Turnstone
Common Gull	Mew Gull
Kittiwake	Black-legged Kittiwake
Puffin	Atlantic Puffin

10. BATHYMETRIC CONTOURS

Bathymetric contours in all associated survey effort maps and sighting/density maps are represented in the following manner:

_____   200m isobath   _ _ _ _ _ 500m isobath   __ __ __ 1000m isobath

11. SEASONAL DEFINITION

Where seasonal trends in seabird densities, relative abundances and distribution are investigated, seasons have been defined on the basis of seasonal daylight levels and average sea surface temperatures for the west of Ireland (Bowyer & Ward, 1995; Boelens *et al.*, 1999). Table 1.2 outlines the three months designated to each season. Histograms outlining survey effort and monthly relative abundance are colour-coded according to the seasons listed in Table 1.2.

TABLE 1.2. Months and histogram colours designated for each season.

Season	Months	Colour
Winter	January, February, March	Yellow
Spring	April, May, June	Purple
Summer	July, August, September	Red
Autumn	October, November, December	Blue

RESULTS & DISCUSSION

OVERALL SURVEY EFFORT

Figure 1.3 outlines the full transect survey effort achieved during the 27 months of the study, including the *SIAR* survey. It represents a total of 442 survey-days at sea, most of which (296 survey-days) were obtained during the spring and summer months (April - September) (Figs. 1.4b & 1.4c).

A total of 836 ¼ ICES grid-squares received varying levels of survey effort. Although 146 person-days were achieved during the autumn and winter months (October - March) (Figs. 1.4a & 1.4d), considerably less full-survey time was obtained, due to poor climatic conditions and the relative low number of daylight hours.

Figure 1.3. Total full transect survey effort carried out by the *Cetaceans & Seabirds at Sea* team between 5 July 1999 and 12 September 2001.

a) Winter

b) Spring

c) Summer

d) Autumn

Figure 1.4. Total full transect survey effort, separated by season. **[**a) *Winter*– January, February, March; b) *Spring*– April, May, June; c) *Summer*– July, August, September; d) *Autumn*– October, November, December].

Figure 1.4 also highlights seasonal differences in the spatial coverage. Thus, the most spatially extensive surveys were achieved in spring, where the effort extended west to the Rockall and Hatton Banks and the southern sector of the Rockall Trough, and southwest over the Porcupine Bank, Porcupine Seabight and the Goban Spur (Fig. 1.4b). The Rockall Bank was also comprehensively surveyed during summer, together with the length of the continental shelf edge and the deep-water region west of the Goban Spur (Fig. 1.4c). Offshore autumn surveys were confined to the general area of the Porcupine Seabight and the Goban Spur (Fig. 1.4d).

Figure 1.5 represents the monthly/seasonal contributions to the total survey effort obtained throughout the study period. Spring (purple) was the most productive season, attributable to the effort achieved during June (>2000km²) and May (ca. 1500km²). The relatively low level of effort obtained in July (ca. 520km²) was due primarily to the time required in preparation for the dedicated *SIAR* survey in 2000. Figure 1.5 also highlights the reduced effort achieved during the Autumn/Winter months (blue/yellow) – the effort achieved in June alone was greater than the combined effort completed between October and March.

Figure 1.5. Full survey effort (km²) by month over the 27-month study. Colours differentiate the seasons defined in Table 1.2.

Figure 1.6. Full transect survey effort conducted during the *SIAR* survey in July-August 2000.

SIAR SURVEY EFFORT

The 22 person-days of full transect effort achieved during the *SIAR* survey is outlined in Figure 1.6. A detailed account of the study area and the methods employed during the *SIAR* survey is outlined in Volume II.

SEABIRD DISTRIBUTION, DENSITY AND RELATIVE ABUNDANCE

This section outlines the sighting records of the seabird, coastal bird and terrestrial bird species observed using the full transect method devised by Tasker *et al.* (1984) and Webb & Durinck (1992).

A total of 113,749 birds of 72 species were recorded during the 27-month study, including those birds recorded during the *SIAR* survey. In total, 37 species of seabirds (n = 110,247; Appendix B), 20 species of inshore and coastal residents/migrants/vagrants (n = 785; Appendix C) and 15 species of terrestrial migrants/vagrants (n = 63; Appendix D) were identified. A further 2,655 seabirds and coastal birds were recorded, but could not be identified to species level.

- **Overall species richness and abundance**

The relative abundance of all seabird species in each of the ¼ ICES squares surveyed is shown in Figure 1.7. The offshore distribution of seabirds was widespread; however the vast majority of grid-squares surveyed displayed low concentrations of seabirds (i.e. <1.0 birds/km). Predictably, relatively high to moderate concentrations of seabirds were recorded in coastal areas, such as Galway Bay and the Shannon Estuary. Seabird concentrations in these regions may be boosted by the presence of large flocks of coastal gull species (Black-headed Gull, Mew Gull and, to a lesser extent, Herring Gull).

Figure 1.7. Relative abundance of all seabird species recorded in each ¼ ICES square surveyed, July 1999–September 2001.

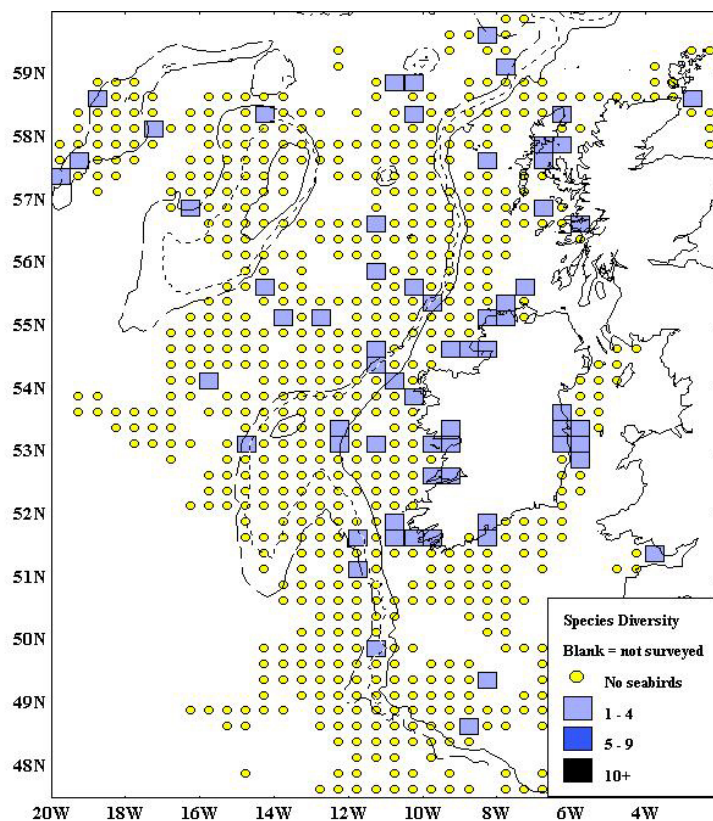Figure 1.8. Number of seabird species recorded in each ¼ ICES square surveyed, July 1999–September 2001.

Figure 1.9. Number of coastal and inshore species recorded in each ¼ ICES square surveyed, July 1999–September 2001.

Potential offshore "hot-spots" displayed moderate to high abundances, including the north and northeast slope of the Porcupine Seabight, the Goban Spur, various areas overlying the Rockall and Hatton Banks and along the continental shelf to the west of the Outer Hebrides (Fig. 1.7). Certain areas (western Porcupine Shelf, northwestern Rockall Bank) displayed superficially high concentrations due to the presence of accumulations of Northern Gannets, Northern Fulmars, and assorted gull species in association with demersal and pelagic fishing fleets.

Figure 1.8 outlines the species richness for seabirds in each of the ¼ ICES squares surveyed throughout the 27-month study period. As expected, moderate to high species richness was recorded along most heavily surveyed coastal areas, particularly during the key breeding period (May-August). Moderate to high offshore species richness was also observed throughout the study, with notable exceptions in areas south and southeast of the Rockall Bank and over deep-water portions of the Porcupine Seabight.

Offshore "hotspots" for species richness included the east and northeast slope of the Porcupine Seabight, along the 200m and 1000m contours northeast and east of the Porcupine Bank respectively, and the northeastern margins of both the Rockall and Hatton Banks. Another offshore region of particular interest was described by a series of grid-squares associated with the 54.4°N line in the centre of the Rockall Trough (Fig. 1.8).

Figure 1.9 (species richness map of coastal/inshore birds) has been included to highlight the relative importance of the offshore environment to seabird species: ten or more seabird species were recorded in circa (ca.) 10% of all the ¼ ICES squares surveyed, while no more than four coastal or inshore bird species were observed in only 71 of the 836 grid-squares surveyed throughout the study period.

- **General comments on all seabird species**

Representatives of the three main seabird classification Orders (i) Procellariiformes, (ii) Pelecaniformes, and (iii) Charadriiformes were recorded throughout the study area.

Members of the Order Procellariiformes (Northern Fulmar, storm petrels and shearwaters) form a group of pelagic birds capable of long-range travel over periods of weeks and months. The Family *Laridae* (larids: gulls and Black-legged Kittiwakes) are a group of birds belonging to the Order Charadriiformes that are frequently encountered in association with human fishing activities. Although Mew, Black-headed and Herring Gulls were frequently recorded near the coast, those species with a more pelagic distribution (Black-legged Kittiwakes, Lesser Black-backed and Great Black-backed Gulls) remain the most relevant gull species in the current study.

Common Guillemots, Razorbills, Atlantic Puffins and Little Auks are representative species of the bird Family *Alcidae* (*Alcids*: auks) that were omnipresent during the 27-month study. The auks are regarded as one of the most vulnerable seabird groups to hydrocarbon pollution due to the large amount of time they spend in contact with the ocean's surface (Webb *et al.*, 1995).

The nearshore habitat of the continental shelf appears to be important for the gulls. This habitat also contained a high proportion of the auks encountered. Shearwaters, Northern Fulmars and storm petrel species dominated the deeper habitats of the continental slope and deep basin waters. Indeed, continental slope waters also appear to be highly important for this group. It is also noteworthy that one third of the species encountered in the deep-water belong to the "others" category, influenced largely by recordings of Northern Gannets, various skua species and a number of key long-distance migratory species, such as the terns.

The corrected seasonal totals for the most frequently encountered offshore seabird species are listed in Table 1.3. The distribution of each of these species is graphically represented below in seasonal density maps (number of birds per km² surveyed). The monthly/seasonal concentrations of most seabird species have been represented using relative abundance histograms (number of animals per km surveyed).

TABLE 1.3. Corrected seasonal (excluding birds associated with the vessel) and total numbers of commonly encountered seabird species recorded on full transect surveys, July 1999–September 2001. (Total A: excludes birds associated with vessel; Total B: includes birds associated with vessel). Multiplication correction factors derived from JNCC database.

Species	Winter	Spring	Summer	Autumn	Total (A)	Total (B)	Corr. Factor
Order Procellariiformes							
Family *Procellariidae*							
Northern Fulmar	3,732	10,270	9,709	684	24,395	33,969	1.1
Great Shearwater	-	1	2,540	2,774	5,315	6,039	1.1
Sooty Shearwater	2	5	593	12	611	1,718	1.1
Manx Shearwater	105	4,553	4,799	28	9,485	9,527	1.1
Family *Hydrobatidae*							
European Storm-petrel	1	416	1,225	3	1,645	1,740	1.5
Order Pelecaniformes							
Family *Sulidae*							
Northern Gannet	3,516	7,235	8,943	630	20,324	22,358	1.0
Order Charadriiformes							
Family *Stercorariidae*							
Great Skua	99	329	302	52	782	856	1.3
Family *Laridae*							
Lesser Black-backed Gull	188	1,565	302	29	2,084	4,340	1.0
Great Black-backed Gull	376	273	224	493	1,366	1,514	1.0
Black-legged Kittiwake	3,528	2,503	1,084	2,741	9,856	12,599	1.2
Family *Alcidae*							
Common Guillemot	1,847	2,483	700	2,045	7,075	7,081	1.4
Razorbill	507	295	293	659	1,754	1,755	1.5
Atlantic Puffin	30	1,164	805	12	2,011	2,023	1.5

- **General comments on coastal and inshore seabird species**

The inshore and coastal birds recorded during the survey period, included resident species (European Shag, Great Cormorant, Black Scoter) and migrants (Greylag Goose, Dunlin, Ruddy Turnstone, Whimbrel [Plate 3]) (Appendix C). Encounters with resident and migrant coastal birds were more frequent than Figure 1.9 and the values in Table 1.4 suggest. Their contribution to the full-survey dataset was reduced due to the alterations of survey vessels' course and speed when close to land. The most numerous migrants recorded were the Greylag/Grey Geese, which were observed in April (2000) during their northwest migration from Scotland to Iceland (Fig. 1.10). During one survey aboard the R.V. *Johan Hjort*, a single adult Whooper Swan was also observed during its return migration to northern breeding grounds (April, 2000).

TABLE 1.4. Seasonal and total numbers of coastal and rarely encountered seabird species recorded on full transect surveys, July 1999 – September 2001. (Total A: excludes birds associated with vessel; Total B: includes birds associated with vessel).

Species	Winter	Spring	Summer	Autumn	Total (A)	Total (B)
Order Procellariiformes						
Family *Procellariidae*						
Cory's Shearwater	-	14	4	3	21	21
Family *Hydrobatidae*						
Wilson's Storm–petrel	-	33	20	-	53	55
Leach's Storm-petrel	-	33	46	3	82	86
Order Pelecaniformes						
Family *Phalacrocoracidae*						
Great Cormorant	12	14	-	132	158	158
European Shag	24	56	11	24	115	115
Order Charadriiformes						
Family *Stercorariidae*						
Pomarine Skua	-	19	25	17	61	69
Arctic Skua	5	30	32	13	80	88
Long-tailed Skua	-	18	6	-	24	27
Family *Laridae*						
Sabine's Gull	-	3	8	-	11	12
Black-headed Gull	10	-	4	4993	5,007	5,008
Mew Gull	241	37	12	885	1,175	1,177
Herring Gull	284	40	8	23	355	417
Family *Sterninae*						
Common Tern	-	40	7	-	47	50
Arctic Tern	-	80	37	-	117	120

- **General comments on terrestrial species**

The terrestrial migrant group included small passerine species (Swifts, Swallows, Meadow Pipits, House Martins), medium passerine species (Rock Dove, Wood Pigeon, Collared Dove), wetland birds (Black Storks, White Storks) and birds of prey (Hobby, Merlin) (Appendix D). Many individuals from this group were perhaps blown off-course by strong offshore winds during overland migrations.

The most unusual sightings from this category involved a single White Stork perched alongside a single Black Stork on the main mast of the R.R.S. *Charles Darwin* as staff tested oceanographic equipment in the deep waters of the Porcupine Seabight (in May 2000). A single juvenile Merlin, sighted approximately 60 nautical miles west of the Galway coast onboard the S.V. *Siren*, appeared to have been responsible for the remains of a storm petrel found on the ship's stern. In addition, an unusual falcon species, at first resembling an Arctic Skua in flight was clearly observed at sea and identified as an Eleonora's Falcon. The relatively large, uniformly dark brown falcon was sighted in good conditions with and without binoculars as it was approached by the survey vessel, while carrying prey in its talons. It was observed feeding on the wing approximately eight nautical miles northwest of the Skellig Rocks, County Kerry in October 2000. This highly unusual record was submitted in detail to the Irish Rare Birds Committee.

Figure 1.10. Sightings of Greylag/Grey Geese and the numbers of birds seen, July 1999–September 2001.

Plate 3. Coastal species, such as Whimbrel (top) and Dunlin (below), were regular shipmates during their outward migrations to winter resting quarters and their return migrations to northern breeding grounds.

- ## **Individual offshore and inshore seabird species**

The following summary is a species by species account of the commonly encountered seabirds and some of the occasional inshore bird records made by the *Cetaceans & Seabirds at Sea* survey team between July 1999 and September 2001, including the *SIAR* survey of August 2000:

Comments in brackets after a species' Latin name indicate the **level of vulnerability** of each species to oil pollution, as outlined in Tasker *et al.* (1990). Levels of vulnerability are defined as follows:

       W = species spends a substantial period of its life on the water surface.
       P = waters west of Britain are important for a large proportion of the species.
       R = species rare on a world basis.
       U = unknown vulnerability. Indicator not provided in Tasker *et al.* (1990).

This classification is based upon:
1. The relative amount of time each species spends in contact with the water;
2. The importance of the waters west of Britain and Ireland to the world population of the species.

Red-throated Diver *Gavia stellata* (Vulnerability: Very high, W)
Concerns regarding the breeding status of the Irish Red-throated Diver population have been expressed, calling for its inclusion to the Red List of the Birds of Conservation Concern in Ireland (Crombie, 2002). A single Red-throated Diver was seen in Galway Bay in October 1999. Individual birds were recorded off-effort in Rathmullan, County Donegal (September 1999) and Killala Bay, County Mayo (January 2000). The three local species of this highly vulnerable group (i.e. Red-throated, Black-throated and Great Northern Divers: Williams *et al.*, 1994) were likely to be under-recorded in the present study, due to their preference for near-shore habitats.

Figure 1.11. Great Northern Diver sightings, July 1999–September 2001.

Great Northern Diver *Gavia immer* (Vulnerability: Very high, W)

The Great Northern Diver is the most widely distributed of the three diver species that winter off Irish shores (Colhoun, 2001). Sixteen Great Northern Divers were recorded during the survey. Moderate numbers of this regular winter visitor were noted in Galway Bay in October 1999 and May 2000 (Fig. 1.11). Subsequent inshore sightings were recorded in Bantry Bay, County Cork and Blacksod Bay, County Mayo during December 2001 and January 2002. Offshore records of Great Northern Divers included a single bird over the southwestern margin of the Hatton Bank (May, 2000) and an adult pair over the Rockall Trough (in May 2001). Subsequently, Mackey *et al.* (2003) recorded Great Northern Divers on ten separate occasions (n=13 birds) over the offshore waters of the Hatton-Rockall Basin/Hatton Bank region during their return migration to northern breeding grounds (May, 2002).

Northern Fulmar *Fulmarus glacialis* (Vulnerability: Moderate)

Northern Fulmar populations have been on the increase in the North Atlantic for well over 200 years (Fisher, 1966; Hamer *et al.*, 1997). The breeding range of this long-lived species expanded during the 20th century from Iceland, the Faeroe Islands and St. Kilda to Ireland (ca. 1911), England (ca. 1922) and Wales (ca. 1931) (Mead, 2000). Although the species obviously benefits from fishery discards (Hamer *et al.*, 1997; Lilliendahl & Solmundsson, 1997), the Northern Fulmar's steady expansion and population increase does not appear to be attributable solely to its scavenging habits (Camphuysen & Garthe, 1997). Lloyd *et al.* (1991) suggest that the Northern Fulmar's population growth may be due to a combination of the increased availability of discards, together with the appearance of a more adaptive genotype and the recent gradual warming of the eastern Atlantic Ocean.

With over 33,600 individuals recorded on-effort, the Northern Fulmar (Plate 4) was the most frequently sighted seabird species during the present survey (Table 1.3). However, it is well known that Northern Fulmars associate with ships and fishing vessels, making accurate estimates of their true abundance difficult to determine. Over 28% of Northern Fulmars encountered during the survey were considered to be in association with the survey vessel (Table 1.3) and, as such, could not be included in density or abundance analyses. A further 13.5% were recorded associated with fishing vessels. Nevertheless, in the present study, there were very few locations in any season, either in shallow or deeper waters, where the Northern Fulmar was not recorded (Fig. 1.13). For example, during the *SIAR* survey of August 2000, the Northern Fulmar was absent from only one grid-square (Fig. 1.14). However, the sighting frequency of Northern Fulmars was lower during southern surveys, particularly south of 50°-51°N between January and September.

> ### Seasonal distribution
> In general, the widespread distribution of the Northern Fulmar reported by Stone *et al.* (1995) and Pollock *et al.* (1997) was also observed throughout the current study. However, the spring and summer offshore distribution (Figs. 1.13b & c) appears to be more widespread than observed by Pollock *et al.* (1997). While the species was particularly numerous in the Rockall and Hatton Bank areas, it was widely but thinly distributed elsewhere.
>
> Northern Fulmars were recorded in every month during the survey period; the peak in relative abundance occurred in February (Fig. 1.12). The low concentrations recorded between October and December may be due in part to the geographical areas that were surveyed at this time (i.e. Porcupine Seabight and Goban Spur). Nevertheless, when compared to the numbers encountered during other seasons, the Northern Fulmar appears to be more widespread south of 51°N in autumn (Fig. 1.13d). It has been

suggested that young birds of the species disperse very widely at this time and that some move westwards, for example, to the Newfoundland region (Pollock *et al.*, 2000).

Although winter effort was limited, it is evident that Northern Fulmar records were generally restricted to offshore and inshore waters north of 51°N (Fig. 1.13a). The decrease in sighting frequency south of 51°N, which was also apparent during spring and summer surveys (Figs. 1.13b & c), was also observed by Stone *et al.* (1995) and Pollock *et al.* (1997). Northern Fulmars were widely recorded during spring and summer in the general area of the Rockall Bank and in the majority of surveyed areas in the Rockall Trough (Figs. 1.13b & 1.13c). There are several large (i.e. *circa* 8000 pairs) breeding colonies in Counties Clare (Cliffs of Moher), Mayo (Clare Island) and Donegal (Horn Head) and it is possible that newly-fledged birds had moved westwards to the continental shelf and indeed beyond to deeper waters (*see* Pollock *et al.*, 2000). However, during the *SIAR* survey numerous moulting fulmars were seen in these latter areas, which suggests that non-breeding and/or post-breeding adult birds were also present.

The relatively high density (>5 birds/km²) of this species found along the western and northwestern margins of the Porcupine Shelf was due to birds associated with pelagic trawlers. The data relating to the distribution of the 37 "blue" morph Northern Fulmars (associated with more northern latitudes) recorded during the survey is not shown.

Figure 1.12.   Relative abundance of Northern Fulmars in each month, July 1999–September 2001.

SIAR survey
The Northern Fulmar was widely distributed during the *SIAR* survey (Fig. 1.14). The highest numbers of this species were recorded along the margins of the continental shelf and in the general area of the Porcupine Shelf. However, reasonably high numbers were also noted in the deeper waters of the Rockall Trough, west of Counties Mayo and Donegal, and west of the Porcupine Bank. These results are in broad agreement with the findings of Pollock *et al.* (1997).

Observations made on feeding behaviour suggest that the Northern Fulmar is an opportunistic feeder whose diet is determined by its seemingly endless and apparently random searching of the ocean surface for food. This, in turn, appears to be associated not only with its well-known aerodynamic skills but perhaps also with exceptional

olfactory abilities. Northern Fulmars were seen feeding on macroplanktonic coelenterates, crustaceans and dead fish of different sizes during the study. Northern Fulmar are also known to regularly take certain squid species (e.g. *Gonatus fabricii*) (Bourne, 1986). Northern Fulmars spend a considerable amount of time indulging in maintenance behaviour, particularly preening. These activities, which have to be conducted on the surface of the sea, obviously increase their vulnerability to hydrocarbon pollution incidents.

Figure 1.13. Seasonal densities of Northern Fulmar separated by season, July 1999–September 2001.

Soft-plumaged Petrel   *Pterodroma* sp.   (Vulnerability: U)

A single Soft-plumaged Petrel was recorded northwest of Donegal, flying in waters overlying the continental slope during the *SIAR* survey (August 2000). This observation represents one of the most northerly locations recorded. Two previous northern records of Soft-plumaged Petrels include single birds recorded along the Faroe-Shetland Channel (Taylor & Reid, 2001; Skov *et al.*, 2002) and in Scottish waters 130km northwest of Lerwick (Pollock *et al.*, 2000).

Plate 4.   Two Northern Fulmars investigating one of 26 sunfish (*Mola mola*) recorded throughout the survey period.

Figure 1.14.   Northern Fulmar distribution during the *SIAR* survey, July-August 2000.

Cory's Shearwater *Calonectris diomedea* (Vulnerability: U)

Although a large movement of over 100 birds in two days was noted off-effort in mid-July 1999, Cory's Shearwaters were very rarely seen during the study and when noted, were found as single individuals or in pairs. Most records appeared to be related to the continental shelf margin around the Porcupine Shelf (Fig. 1.15), although there was also one sighting of this species in the Irish Sea in November 1999. Three Cory's Shearwaters were recorded during the *SIAR* survey (August 2000). No records were made north of 55N°.

This shearwater, which breeds in Portugal and the Mediterranean, and on the Azores, Madeira, the Selvagens, and Cape Verde Island (Hagemeijer & Blair, 1997), is a scarce but annual visitor to Irish waters in variable numbers, occurring usually in the summer (Evans, 1981) or the early autumn (Hutchinson, 1989). Stone *et al.* (1995), Pollock *et al.* (2000), Taylor & Reid (2001) and Mackey *et al.* (2003) recorded Cory's Shearwater within the latitudes of 55°N and 63°N between May and October. The most westerly record within this region was reported by Mackey *et al.* (2003): a single bird west of the Hatton Bank (~57° 53'N, 22° 45'W) in May 2002. It is a species that might be expected to increase in the Hatton-Rockall region if climate change brings about a general increase in temperature.

Figure 1.15. Cory's Shearwater distribution, July 1999–September 2001.

Great Shearwater *Puffinus gravis* (Vulnerability: U)

Along with the Sooty Shearwater, the Great Shearwater (Plate 5) is a summer transequatorial migrant that breeds exclusively on islands in the South Atlantic (e.g. Tristan de Cunha). Over 87% of all Great Shearwater sightings were recorded in September and October (Fig. 1.16). Overall sightings of this pelagic species were generally restricted to a period between August and November, although individual sightings of single birds also occurred in the months of June and July. These results are markedly different to those of Pollock *et al.* (2000). Approximately 12% of all Great Shearwater sightings were recorded in association with survey vessel used in the study, with a further 3.5% recorded in association with fishing vessels.

As with the monthly distribution pattern detected for Northern Fulmars (Fig. 1.13), the seasonal trend in distribution of the Great Shearwater (Fig. 1.17) may be somewhat influenced by the areas surveyed at these times (i.e. almost exclusively to the west and southwest of Ireland). While the latter surveys do not permit extrapolation to the wider areas of the Rockall Trough they do show that, in October, the Great Shearwater may be almost seven times more abundant than the Northern Fulmar in the deeper waters of the Porcupine Seabight - Goban Spur area.

Figure 1.16. Relative abundance of Great Shearwaters recorded in each month, July 1999-September 2001.

Plate 5. Large accumulations of the migratory Great Shearwater were commonly encountered associated with survey vessels between August and October.

It would be interesting to establish if this is a persistent trend and to confirm that the spatial distribution of the Great Shearwater is as restricted in the September-October period as the results suggest. During the late summer, the Great Shearwater was found to be numerous and widespread along the shelf margin, especially in the area of the Porcupine Bank (Fig. 1.17c). As this species migrates south, it became more numerous in the Porcupine Seabight (Fig. 1.17d). This latter feature is in marked contrast to the distribution of the Manx Shearwater (*compare* Fig. 1.17d & Fig. 1.20d), but not dissimilar to that of the Northern Fulmar (*compare* Fig. 1.13b & Fig. 1.17d). It is interesting to note that the Great Shearwater was more widespread and numerous than recorded by Pollock *et al.* (1997).

a) Winter   **b) Spring**   **c) Summer**   **d) Autumn**

Figure 1.17. Great Shearwater seasonal densities, July 1999–September 2001.

SIAR survey

The Great Shearwater was recorded as widely distributed during the *SIAR* survey (Fig. 1.18) but notably was virtually absent from the deeper waters of the northwest Rockall Trough. Although the species was numerous in deep water, it was also encountered along the shelf margin but was not abundant in inshore areas. Small groups of up to 15 Great Shearwaters were frequently observed associating with the survey ship. Observations were also made on the feeding- and maintenance-behaviour of Great Shearwaters during the *SIAR* survey. As with the Northern Fulmar, the Great Shearwater spends considerable periods of time searching for prey on the wing. Food items are obtained by shallow aerial dives and, in the present study, appeared to be composed exclusively of macroplanktonic prey. A notable feature of the species' recorded ecology at sea was the fact that it seems to have been differentially selected, along with juvenile Northern Gannets, by Great Skuas for kleptoparasitic attack.

Figure 1.18. Great Shearwater distribution during the *SIAR* survey, August 2000.

Manx Shearwater *Puffinus puffinus* (Vulnerability: Very high, W, P)

The Manx Shearwater breeds in large colonies particularly off the coast of County Kerry (Lloyd *et al.*, 1991; Heath & Evans, 2000; O'Clery, 2002). However, because it is a nocturnal, burrowing species utilising scree-like terrain on offshore islands of, for example Inishtearaght and Skellig Michael, abundance estimates of the species are difficult to obtain (Brazier & Merne, 1989). Consequently, the estimate of the total size of the Irish breeding population was believed to range from 7,550 to 42,200 pairs (Lloyd *et al.*, 1991; Pollock *et al.*, 1997). Interestingly, recent surveys of the Blasket Islands indicate the presence of a larger population of Manx Shearwaters than that previously estimated, and the total Manx Shearwater population of County Kerry may number about 40,000 pairs (Newton & Mitchell, 2001). Both Lighthouse Island and Copeland Island, County Down, also appear to host greater numbers of Manx Shearwaters than estimates first indicated (up to 13,000 birds of all ages: J. Stewart, Copeland Bird Observatory, 2002, *pers. comm.*). However, the population of west Great Britain is in excess of 142,000 pairs (Pollock *et al.*,

1997), and it is probably these birds that are recorded migrating past Cape Clear Island (County Cork) and the south coast during the early autumn (Hutchinson, 1989). The species also breeds in Iceland and on the Faeroe Islands, though these populations appear to be relatively small, especially those in Iceland (Brooke, 1990).

This migratory species appears to winter (at least the yearling birds) off the east coast of South America (Brooke, 1990; Lloyd *et al.*, 1991) and there is a very sharp decline in numbers off the Irish coast in late autumn. Winter records are very scarce in the north of the study area, while its winter status in the south is undetermined (Hutchinson, 1989). Interpreting the data collected while surveying for Manx Shearwaters at sea is made difficult by the fact that this species sometimes forms large, localised sitting/feeding flocks or rafts. Statistically, this can lead to a classic "clumped distribution" and perhaps misleading the quantitative analyses.

When compared to the Northern Fulmars (28.2%), Great Shearwaters (12.0%) and Sooty Shearwaters (64.4%), Manx Shearwaters showed little interest in associating with survey vessels; only 0.4% of all Manx Shearwater records were considered to be in association with survey vessels. Similarly, Manx Shearwaters were not commonly recorded in association with fishing vessels. Manx Shearwater sightings also differed from those of its three relatives, in that this relatively independent species was not targeted by the kleptoparasitic advances of the Great Skua.

Figure 1.19. Relative abundance of Manx Shearwaters recorded in each month, July 1999–September 2001.

The Manx Shearwater was recorded in nine out of ten months, spanning the period from February to November (Fig. 1.19). A lack of records in October may be due in part to sampling error. August was the peak month for recordings (ca. 42% of all sightings), but numbers encountered were also relatively high in May (ca. 22%) and June (ca. 25%).

SIAR survey

Manx Shearwaters were recorded in many of the deep-water grid-squares of the Rockall Trough (Fig. 1.20). Generally, the species was not found to be very numerous except in grid-squares located close to Achill Island (County Mayo) where some large feeding flocks of up to 400 birds were encountered. Over 82% of the 1,549 Manx Shearwaters recorded during the *SIAR* survey were observed west of Achill Island.

Figure 1.20. Manx Shearwater distribution during the *SIAR* survey, August 2000.

Seasonal distribution

The Manx Shearwater was widely distributed in spring and summer (Figs. 1.21b & c). Moderate to large densities were recorded in the shallower waters of the continental shelf within foraging range of Irish and Scottish breeding colonies, such as the Blasket Islands, Puffin Island, Great Skellig, the Saltee Islands, Lambay Island, the Western Isles. Interestingly, the Rockall Bank, the northern slope of the Porcupine Bank, and to a lesser extent, the Hatton Bank appear to be important feeding grounds for the Manx Shearwater during the spring-summer period (Figs. 1.21b & c). The relatively high concentrations recorded between April and June (Fig. 1.21b) over the Rockall and Hatton Banks may relate to non-breeding immature birds, while the deepwater regions north and northwest of the Porcupine Bank fall within the foraging range of the western- and southwestern-Irish breeding population (Coulson, 2002). It is possible that breeding birds from the Faeroes and western Scotland (e.g. Isle of Rhum) use the deep waters in the northern and central sectors of the Rockall Trough as foraging grounds. These data would appear to lend support to Brooke's (1990) hypothesis that the Bay of Biscay is no longer a major feeding ground for breeding Manx Shearwaters. The widespread nature of the distribution depicted in Figures 1.21b and 1.21d contrasts with the limited records reported by Pollock *et al.* (1997) in the deep waters to the west of the Ireland for the same period.

Apart from the Irish Sea, there is a distinct westerly trend to the distribution of Manx Shearwaters in the summer (Fig. 1.21c), perhaps more so than was reported by Pollock *et al.* (1997). The Manx Shearwater was rarely encountered in the western Celtic Sea. Although the species was widely recorded over the Porcupine Shelf, the Manx Shearwater's distribution over the southern sectors (including the Porcupine Seabight and the Goban Spur and the deeper waters to the west of the Little Sole Bank) was limited (Fig. 1.21).

Figure 1.21. Manx Shearwater seasonal densities, July 1999–September 2001.

Manx Shearwaters are considered to be rare in Ireland during winter (Hutchinson, 1989). The species was recorded infrequently in coastal waters during the winter and autumn in the present study (Figs. 1.21a & d). Apart from isolated sightings over the northern slope of the Porcupine Seabight and the shelf waters west of Counties Galway and Clare, the Manx Shearwater was notably absent from all offshore grid-squares that were surveyed at this time of year. Our results are not directly comparable with those of Pollock *et al.* (1997), but nevertheless appear to be in broad agreement with their findings.

Mediterranean Shearwater *Puffinus yelkouan mauretanicus* (Vulnerability: U)
Four Mediterranean Shearwaters were noted in a feeding aggregation of seabirds off southeast Ireland in early November 1999. Other surveys recorded this species in small numbers between the months of July and November as they dispersed north through Irish and British waters from their Mediterranean breeding grounds (Stone *et al.*, 1995; Pollock *et al.*, 1997; Pollock *et al.*, 2000).

Sooty Shearwater *Puffinus griseus* (Vulnerability: High)
The Sooty Shearwater (cover plate) breeds on islands in the southern Pacific and Atlantic Oceans. This long-range migrant was recorded in the present study between May and November (Fig. 1.22). There is a clear peak in August (ca. 86% of all sightings), though high numbers were also encountered in September (ca. 11%). This seasonal trend is consistent with sea-watch data recorded from the mainland of Ireland (Hutchinson, 1989).

Over 1,700 Sooty Shearwaters were recorded throughout the study period. Of these records, >64% of all Sooty Shearwater sightings were observed in association with the survey vessels, and as such, could not be included in density and abundance analyses. This rate of association was the highest recorded for any seabird species throughout the study period. It can be seen that the Sooty Shearwater was widely distributed during the summer, being found over the Rockall Bank and Porcupine Shelf and over other continental shelf waters (Fig. 1.23c). The largest aggregations (ca. 500 birds) were observed in close proximity to the island of Rockall in August 2001. Limited numbers of Sooty Shearwaters were detected over the Goban Spur in October/November, presumably as they continued on their southward migration in the autumn (Fig. 1.23d).

In general, the distribution maps of the Sooty Shearwater and Great Shearwater (Fig. 1.17) are similar, and contrast to a certain extent with that of the Manx Shearwater (Fig. 1.21).

SIAR survey
Sooty Shearwaters were quite widely but thinly distributed during the *SIAR* survey; of the 139 Sooty Shearwaters recorded, only one sighting involved more than three birds. There was evidence of this shearwater species associating with the survey vessel in pairs or singly, but this species was never numerous.

Figure 1.22. Relative abundance of Sooty Shearwaters recorded in each month, July 1999–September 2001.

Figure 1.23. Sooty Shearwater seasonal densities, July 1999-September 2001.

European Storm-petrel *Hydrobates pelagicus* (Vulnerability: Moderate)
The remote islands off the west coast, including the Blasket Islands and Puffin Island, County Kerry and Illaunmaistir, Inishglora and Inishkeeragh, County Mayo, appear to be of greatest importance to Ireland's European Storm-petrel population (Brazier & Merne, 1989; Heath & Evans, 2000; O'Clery, 2002). Initial results from a census of seabirds in western Ireland indicate that the 26,000 European Storm-petrels occupying sites on Inishtooskert, County Kerry, may represent the largest colony in the world (Newton & Mitchell, 2001). A recent survey of Leach's Petrel on the Stags of Broadhaven, County Mayo, also located a smaller colony of approximately 1,905 European Storm-petrels (Newton, 2002).

Sightings of European Storm-petrels accounted for over 92% of all small petrel records. However, although the species may be Ireland's most numerous seabirds, it was only the tenth most frequently recorded species during the present study. This is believed to be largely due to the animal's small size. As Ireland's smallest seabird, the European Storm-petrel is one of the most difficult to detect at sea, particularly in rough seas. Along Ireland's Atlantic Margin, an area notorious for its rough seas, the species is commonly detectable with the naked eye only when individuals approach within 100-150m of the survey vessel. This inevitably leads to a reduced detection of the species on "Seabirds at Sea" surveys and those conducted in the present study, on which binoculars were not used as part of the search effort. Therefore, a level of care should be taken in interpreting the data presented below.

Seasonal distribution

The European Storm-petrel was recorded through a nine-month period from March to November (Fig. 1.24). A strong increase was observed from May through to the peak month (August), when over 50% of the records were observed. After a significant decrease in sightings during September, only six storm petrels were recorded between the months of October (1999/2000) and April (2000/2001).

The European Storm-petrel was widely but thinly distributed in summer (Fig. 1.25c), where it was mainly recorded along the shelf margin and north of the Porcupine Seabight. The majority of birds recorded during July and August probably included breeding individuals foraging to feed their chicks, and non-breeding immature birds, which aggregate in the northeast Atlantic Ocean during this period (Pollock *et al.*, 1997).

Figure 1.24. Relative abundance of European Storm-petrels recorded in each month, July 1999–September 2001.

While the species was also recorded over the Hatton Bank during May and June (2000), the European Storm-petrel was largely absent from the deeper water grid-squares of the Rockall Trough in spring (Fig. 1.25b). In spite of considerable research effort throughout the Atlantic Margin, most sightings south of the Outer Hebrides were concentrated off the west coast of Ireland, extending westwards into the Porcupine Shelf. However, even though this region is relatively close to Ireland's largest storm petrel colonies, it is perhaps surprising that very large aggregations of birds were not recorded at sea.

The results of the *SIAR* survey greatly influenced the pattern of summer records (Fig. 1.25c). Nevertheless, there was almost a complete absence of records from the southwest

(i.e. Porcupine Seabight, Goban Spur and Little Sole Bank) despite this area having been extensively surveyed (Figs. 1.25b & c). These interesting results contrast sharply with the findings of Pollock *et al.* (1997), who recorded this species as both widespread and numerous in summer. This storm petrel species was found to be virtually absent from Irish waters in winter and autumn (Figs. 1.25a & d).
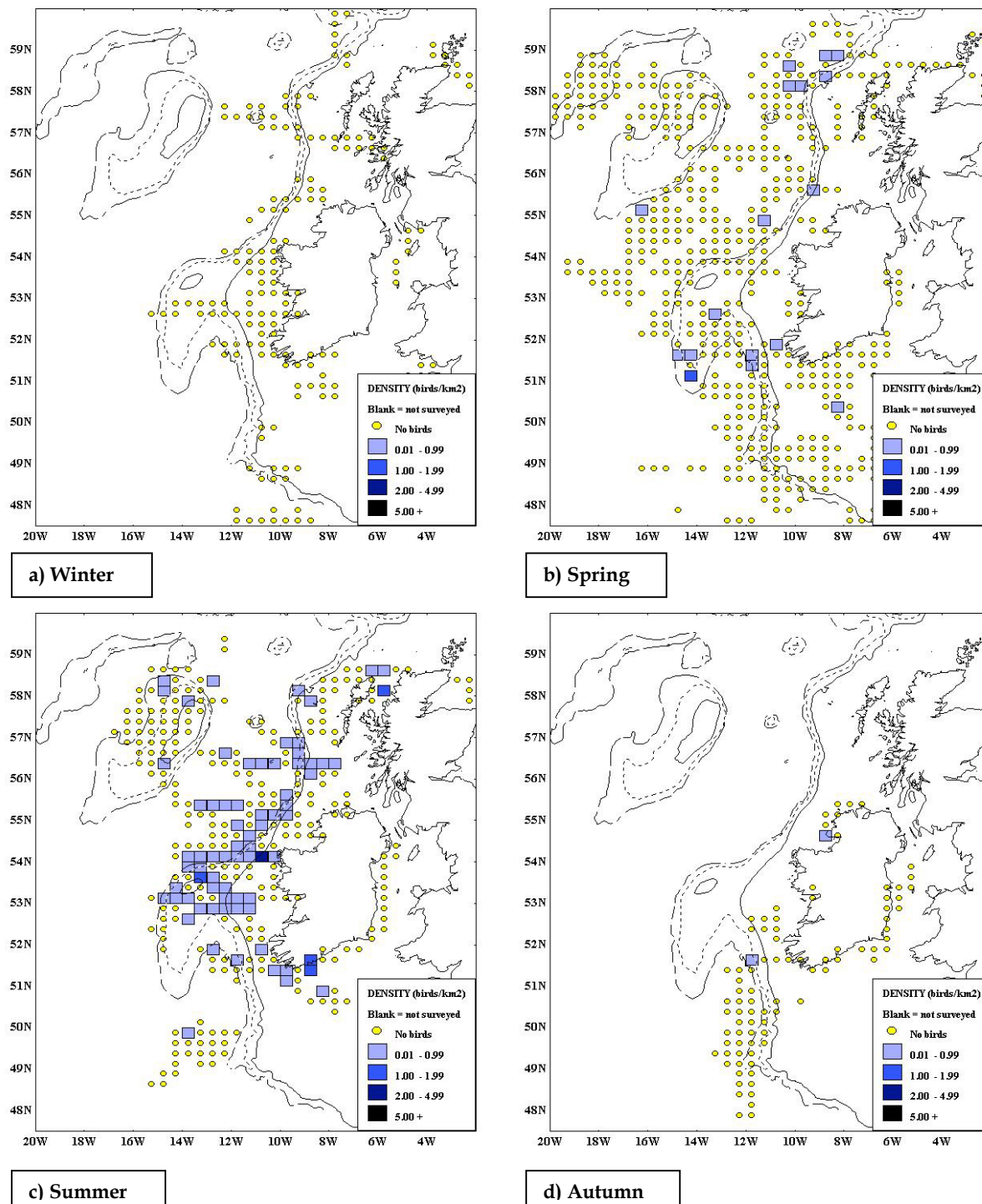

Figure 1.25. European Storm-petrel seasonal densities, July 1999–September 2001.

SIAR survey

The distribution of the 821 European Storm-petrels recorded during the *SIAR* survey is shown in Figure 1.26. It can be seen that while this species was never abundant it was widely distributed over the study area from the Rockall Trough to the shallower waters off County Mayo and County Clare.

Figure 1.26. European Storm-petrel distribution during the *SIAR* survey, August 2000.

Wilson's Storm-petrel *Oceanites oceanicus* (Vulnerability: U)

The Wilson's Storm-petrel is a not a native of the North Atlantic, but a relatively rare visitor, especially to offshore waters. Reputed to be one of the world's most numerous seabirds (Enticott & Tipling, 1997), this Antarctic breeder's true population status remains unknown. The 55 recorded sightings (3.0% of all small petrel records) were considerably higher than previously noted by Pollock *et al.* (1997) and Pollock *et al.* (2000). All sightings in the present study were made between the months of May and September during their northerly post-breeding dispersal (Fig. 1.27).

Sightings were located over the deep waters of the Rockall Trough or along the continental shelf edge, but there were also records from inshore waters off County Cork (Fig. 1.28). Fifteen of the 16 Wilson's Storm-petrels noted north of latitude 53°N were recorded in August; the remaining record occurred in September. Two of the August records were noted over the southwestern margin of the Rockall Bank (Fig. 1.28). Almost 97% of the May-June records were made over the Celtic Sea, Goban Spur and along the northeastern margin of the Porcupine Seabight (between 47.63°N and 51.63°N). No sightings of Wilson's Storm-petrels were obtained in the month of July.

Figure 1.27.   Relative abundance of Wilson's Storm-petrels recorded in each month, July 1999–September 2001.

Figure 1.28. Wilson's Storm-petrel sightings July 1999- September 2001.

Leach's Storm-petrel *Oceanodroma leucorhoa* (Vulnerability: Moderate)

There were 86 sightings of Leach's Storm-petrels during this survey, only 4.7% of all small petrel sightings. The Leach's Storm-petrel, therefore, can be regarded as a rare species within the pelagic seabird community off the west coast of Ireland. The largest breeding colonies for this species are located on remote islands off western Scotland, such as St. Kilda and the Flannans (Mead, 2000). The breeding status of the Leach's Storm-petrel in Ireland is still uncertain, but it is believed that the population is small and perhaps confined now to County Mayo, County Donegal (Lloyd *et al.*, 1991; Heath & Evans, 2000; Mead, 2000) and County Kerry (Moore *et al.*, 1997). A recent survey of a breeding colony on the Stags of Broadhaven, County Mayo, tentatively estimated its population of Leach's Storm-petrels at 310 birds (Newton, 2002).

Approximately 84% of all Leach's Storm-petrel sightings were recorded between June and August (Fig. 1.29). Leach's Storm-petrels were not recorded between the months of November and April.

Figure 1.29. Relative abundance of Leach's Storm-petrels recorded in each month, July 1999–September 2001.

An apparent preference of Leach's Storm-petrel for the deep waters of the Rockall Trough was obvious in the present study. Almost all the Leach's Storm-petrel sightings in this study related to the Rockall Trough, either at the continental shelf break, south of the Porcupine Bank or over the deeper waters of the Rockall Trough (Fig. 1.30). There were also some sightings of Leach's Storm-petrels in the Porcupine Seabight, although most records were from grid-squares north of the Porcupine Bank (Fig. 1.30).

Geographically, it would appear that these petrels are relatively scarce in the shallower waters of southwest Ireland. Bourne (1986), Pollock *et al.* (1997), Pollock *et al.* (2000) and Reid *et al.* (2001) recorded similar distribution patterns to those of the present study. Records of Leach's Storm-petrels during sea-watches at Cape Clear Island, off western County Cork are comparatively rare. Reid *et al.* (2001) observed that the Leach's Storm-petrel restricts its breeding distribution to St Kilda and North Rona and other sites close to the continental shelf edge. The species is, however, commonly recorded from relatively "in-shelf" locations such as off the Bridges of Ross (County Clare) (McAdams *et al.*, 1999; McAdams *et al.*, 2000; Milne *et al.*, 2002; Milne, 2003). Indeed, the large numbers that are observed streaming past Loop Head in late summer are thought to come from the 42,000+ Leach's Storm-petrels occupying colonies on St. Kilda's Dun, Boreray, Hirta and Soay islands (Newton & Mitchell, 2001).
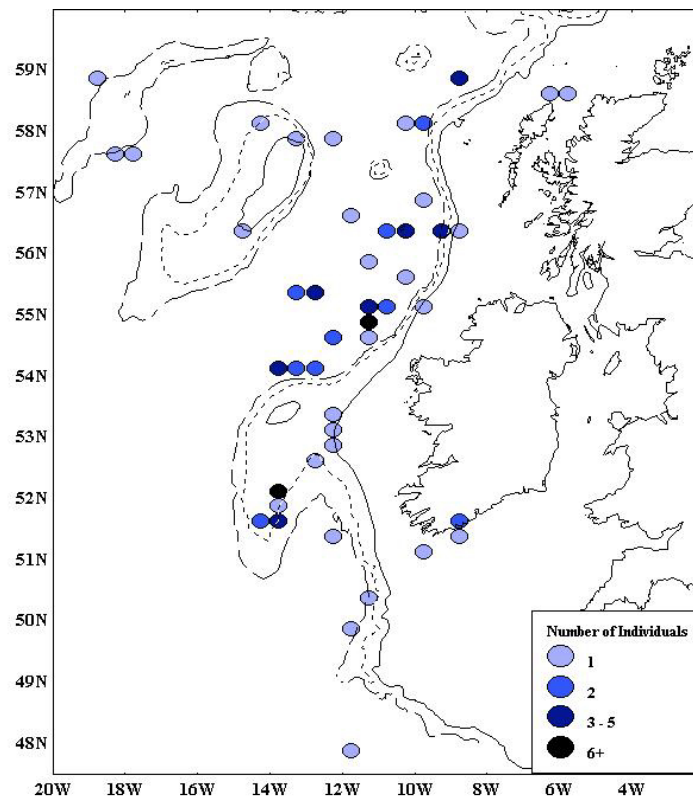
Figure 1.30. Leach's Storm-petrel sightings July 1999- September 2001.

Northern Gannet *Morus bassanus* (Vulnerability: High, P)

Approximately 80% of the European population of Northern Gannets is contained within Ireland and Britain (Mead, 2000). Large Northern Gannet breeding colonies are located on the Little Skellig (County Kerry: Fig. 1.1; Lavelle, 1999) and Bull Rock (County Cork) as well as on St. Kilda, Ailsa Craig, North Rona, Fair Isle and Sule Skerry off western Scotland. Pollock *et al.* (1997), suggest a total breeding population adjacent to the Rockall Trough of approximately 92,500 pairs (excluding Scottish colonies, such as St. Kilda, Sula Sgeir and North Rona).

Figure 1.31. Relative abundance of Northern Gannets recorded in each month, July 1999 – September 2001.

a) Winter

b) Spring

c) Summer

d) Autumn

Figure 1.32. Northern Gannet seasonal densities, July 1999–September 2001.

Seasonal Distribution

The Northern Gannet (Plate 6) was the second most numerous seabird species recorded during surveys, with over 22,300 sightings in the present study (Table 1.3). Over 9% of all sighting records were obtained of birds in association with the various survey vessels used, and a further 12.8% were recorded in association with fishing vessels. Northern Gannets were recorded in every month with an annual peak in relative abundance occurring in the month of September (Fig. 1.31). Numbers recorded during August and September account for over 41% of the total annual sightings. A secondary peak noted in January was due to the low level of effort achieved (*see* Fig. 1.5) and together with relatively high occurrences recorded in February and March, reflects the Northern Gannet's wide shelf distribution (Fig. 1.32a).

It is important to note the low relative abundance of Northern Gannets in October, November, and December, when offshore survey effort was restricted to the Porcupine Seabight and the Goban Spur (Fig. 1.32d). The Northern Gannet was recorded as widely distributed in summer, being present in most of the surveyed grid-squares (Fig. 1.32c). The highest densities were, not surprisingly, recorded off western Scotland and southwest Ireland, which, as mentioned above, contain well-known breeding strongholds for the species.

 The Northern Gannet was widely dispersed over the waters of the Rockall Trough as well as shallower shelf waters in summer. Summer reductions in sighting frequency were obvious over the Rockall Bank and the Porcupine Abyssal Plain west of the Goban Spur, south of 50°N (Fig. 1.32c). The species is present in low to moderate numbers over both the Rockall and Hatton Banks and in the deeper waters of the Rockall Trough during spring (Fig. 1.32b). It is also clear that Northern Gannets were widely dispersed in low to moderate concentrations over southern coastal waters, the Celtic Sea and western approaches.

Plate 6. Northern Gannets were frequently observed scavenging on discards from fishing vessels. This individual was photographed searching for discards in the stern wash of the F.R.V. *Scotia*.

It would be interesting to know what segment of the North Atlantic's Northern Gannet population inhabits the Rockall and Hatton Banks. Immature Northern Gannets are migratory, with some wintering as far south as West Africa (Cramp *et al.*, 1974). However, the breeding adults are only partial migrants (Lloyd *et al.*, 1991) and even this behaviour may alter with climate change. The seasonal and geographical patterns of age structure of Northern Gannets recorded during this study will be informative. Most of the largest concentrations were found off the west of Ireland and to a lesser extent, Scotland. The data would suggest that future surveys should investigate further the western and southern sectors of the Rockall Trough in winter and autumn.

SIAR survey

As can be seen in Figure 1.33, the Northern Gannet was widely distributed during the *SIAR* survey. While the species was absent from some of the deepwater grid-squares in the Rockall Trough it was present, and sometimes very numerous, in all but two of the shallower water grid-squares. The behaviour of Northern Gannets at sea was studied during the *SIAR* survey and the results are summarised here.

When Northern Gannets are not foraging, they spend a considerable period of time on the water surface indulging in maintenance behaviours, particularly preening, washing and sleeping. During this time, they are vulnerable to hydrocarbon pollution. As with Northern Fulmars, the Northern Gannets are mostly found as isolated individuals (or pairs) or in small groups. However, very large resting rafts have been observed in association with fishing vessels, and it is these aggregations, in particular, which may be susceptible to oil slicks. A number of recorded birds appeared to have swallowed brightly coloured rope, net (Lloyd *et al.*, 1991), plastic and other material (e.g. sea-angling traces). However, many such birds were seen to both feed and preen despite the prolonged presence of this obstacle in the oesophagus.

Figure 1.33. Northern Gannet distribution observed during the *SIAR* survey, August 2000.

Great Cormorant *Phalacrocorax carbo* (Vulnerability: Very high W, P)

Over 150 Great Cormorant records were obtained from inshore areas around the Irish coast (Fig. 1.34). Both the Great Cormorant and the European Shag have incomplete waterproofing of their plumage and are therefore required to periodically emerge from the water in order to dry out their plumage (Walker, 1956; Rijke, 1968). This is believed to limit the distance that the Great Cormorant may travel from land, which probably explains the complete absence of offshore records in the present study. Although the majority of Great Cormorants breeding in Ireland and Britain are considered to be resident (Lloyd *et al.*, 1991), part of the Irish and British Great Cormorant populations have been known to move to southwest England, west and northwest France and even to Iberia (Cramp *et al.*, 1974; Prater, 1981; Budworth *et al.*, 2000).
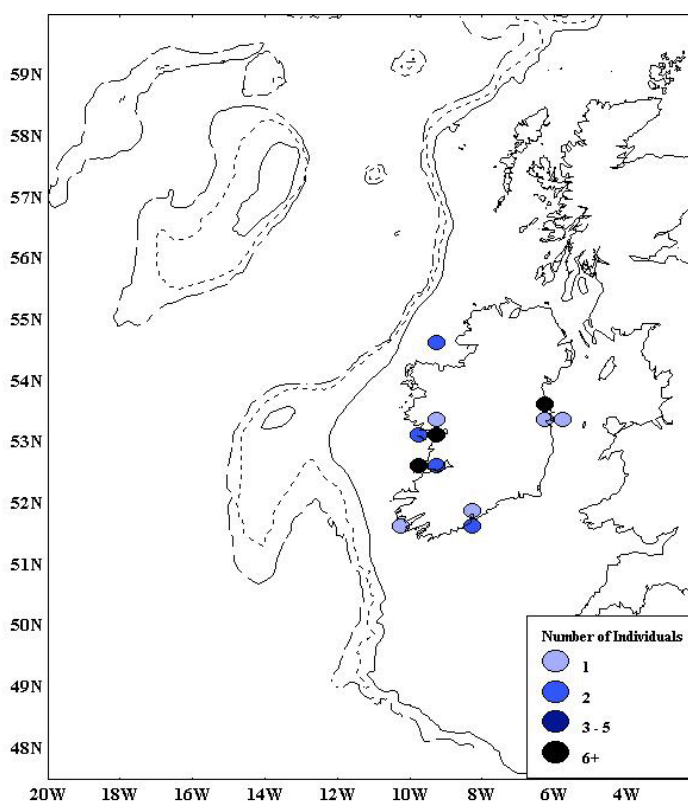
Figure 1.34. Great Cormorant sightings, July 1999–September 2001.

European Shag *Phalacrocorax aristotelis* (Vulnerability: Very high W, P)
The distribution of the European Shag as recorded in this survey is shown in Figure 1.35. Like the Great Cormorant, the European Shag is generally associated with inshore waters (Lloyd *et al.*, 1991; Wanless *et al.*, 1997) and was completely absent from deepwater habitats during the current study. The European Shag is more of a marine species than the Great Cormorant and this is reflected in the slightly wider distribution of records. A total of 112 European Shags were recorded during the survey period.

Black Scoter *Melanitta nigra* (Vulnerability: Very high W)
Many of the 35 Black Scoters recorded during full surveys were observed outside of the study area, over the Irish Sea, the Armorican Shelf and the English Channel. A small group of three Black Scoters was observed flying south over the Irish Sea in October 1999. Several small groups of this coastal duck species were also recorded within the study area, although when off survey effort (in Killala Bay, County Mayo; Bantry Bay, County Cork; Tralee Bay, County Kerry).

Grey Phalarope *Phalaropus fulicarius* (Vulnerability: U)
This Arctic-breeding species is regularly recorded on the west coasts of Ireland and Britain, as gales bring single or small groups of southward-migrating birds inshore during September/October (Svensson & Grant, 1999). A group of four Grey Phalaropes was noted on the sea surface west of the Aran Islands, County Galway, in October 2000. A single bird was also noted by an off-effort researcher, as it flew south over the Rockall Bank in September 2000.

Figure 1.35. European Shag sightings, July 1999–September 2001.

Great Skua *Stercorarius skua* (Vulnerability: Moderate)

The Great Skua (Plate 7), also known as the "bonxie", is on the Red Data Book's list of birds due to the international importance of the British breeding population (Batten *et al.*, 1990; Sears *et al.*, 1995). It is interesting to note that the Great Skua has recently been discovered breeding in western Ireland (Newton, 2001b; Newton *et al.*, 2002).

The Great Skua was the most frequently encountered skua species throughout the study period (Tables 1.3 & 1.4), accounting for 82% of all skua sightings. Great Skuas were recorded in every month except January (Fig. 1.36). March was the peak month in terms of Great Skua abundance, although numbers recorded were also relatively high in April, May, August and September. The main peak in March and April may be due to the northward migration of adults to breeding grounds in Shetland, the Western Isles and the north/northwest coasts of mainland Scotland (Furness, 1987). The offshore distribution observed in winter (Fig. 1.37a) may explain why the March peak does not correlate with the monthly trend detected at land-based sea-watch stations, such as Cape Clear Island (Hutchinson, 1989). The second peak observed in August and September, may be due to the southward movement of both adults and fledglings to wintering grounds off the Iberian Peninsula, northeastern South America or northwestern Africa (Furness, 1987). The winter movement and distribution of this highly aggressive species varies quite considerably, depending on the individual bird's age and fledging/nesting location (Furness, 1987; Olsen & Larsson, 1997). Great Skuas are considered to be rare in Irish waters in winter (Hutchinson, 1989). However, Pollock *et al.* (1997) recorded the highest densities of Great Skuas during November and December off the south of Ireland.

The Great Skua was widely distributed at low densities, its range extending over both the Rockall and Hatton Banks (Fig. 1.37). The species was most widely encountered in spring especially in the northern sector of the Rockall Trough and adjacent areas, though not to a significant extent in deeper waters (Fig. 1.37b). Elsewhere, it was mainly found in close association with the shelf edge along the Porcupine Seabight and Goban Spur. Some individual Great Skuas were also found in the Celtic Sea and two birds were also recorded over the deep

water of the Porcupine Abyssal Plain in April 2001. The current distribution thus appears to be considerably more extensive in Irish waters than that recorded by Pollock *et al.* (1997).
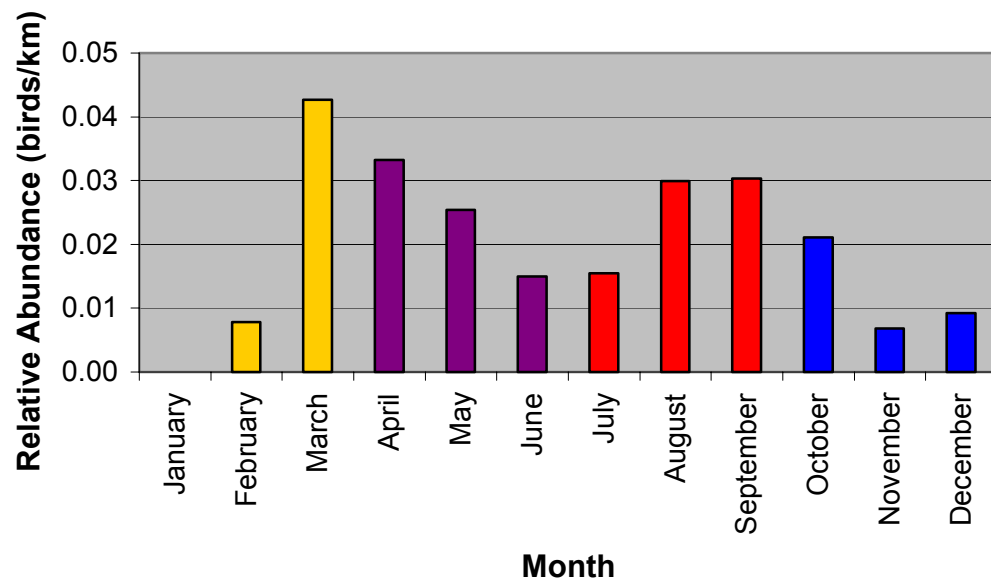

Figure 1.36. Relative abundance of Great Skuas recorded in each month, July 1999–September 2001.

Plate 7. A Great Skua hovers above a disturbed Northern Fulmar (right). The large skua species was frequently observed making kleptoparasitic attacks on Great Shearwaters and Northern Gannets.

There appears to have been a more southerly trend in the distribution of the Great Skua in summer (Fig. 1.37c). Records were less frequent in summer than in spring in the Rockall Bank area, but much more extensive over the Porcupine Shelf. However, this pattern may be explained, in part, by the variation in survey effort and the systematic transecting of the Porcupine Shelf during the *SIAR* survey (August 2000), during which the Great Skua was widely recorded and sometimes relatively numerous. The Porcupine Shelf was also a relatively popular site during the winter months (Fig. 1.37a).

Figure 1.37. Great Skua seasonal densities, July 1999–September 2001.

Great Skuas were regularly observed undertaking kleptoparasitic (i.e. piracy) attacks, particularly on Great Shearwaters (ca. 53%) and both juvenile (1st- and 2nd-winter) and adult Northern Gannets (ca. 37%). Sooty Shearwaters, Northern Fulmars and Lesser Black-backed Gulls were also the focus of kleptoparasitic attack, some incidents involving mixed species groups. Almost 6% of all Great Skua sightings involved kleptoparasitic activity. All kleptoparasitic incidents were observed between the months of April and October and over 52% of attacks were recorded within August and September. Great Skuas were also occasionally observed associating with offshore fishing fleets.

Pomarine Skua *Stercorarius pomarinus* (Vulnerability: U)

Pomarine Skuas were recorded in low numbers relative to the Great Skua, accounting for less than 7% of all skua sightings during the study. This Arctic-breeding species was recorded in every season except winter; highest relative abundances were detected in November and October (Fig. 1.38), which agrees in part with Furness (1987), who suggested that the peak southward migration as observed from Cape Clear Island (County Cork) occurs during October. However, a peak in November was unexpected and warrants further research. Four of the 69 Pomarine Skua records involved kleptoparasitic attacks on adult Black-legged Kittiwakes (Plate 7), a small gull species not targeted by the Great Skua during sighting records obtained in the present study. Where plumage was recorded, 72% were identified as pale-phase adult and juvenile Pomarine Skuas.

Figure 1.38. Relative abundance of Pomarine Skuas recorded in each month, July 1999–September 2001.

Some interesting patterns emerged during the present study. In summer, the majority of records were from the Rockall Trough (Fig. 1.39) with virtually no sightings from inshore areas. In spring there were few records, mostly from the Hatton and Rockall Banks. In winter, all records were from inshore areas. A subsequent survey by Mackey *et al.,* (2003) identified the Hatton-Rockall region as potentially important during the spring migration. A total of 340 birds were recorded during this five-week survey of the Hatton Bank and Hatton-Rockall Basin in May 2002.

SIAR survey

Pomarine Skuas were widely recorded in low concentrations during the *SIAR* survey (Fig. 1.40). These individuals were probably immature and non-breeding birds, which are believed to migrate south in July and August (Furness, 1987). The great majority of these birds were pale-phase adults in full summer plumage. Although limited, these sightings reaffirm the importance of the Rockall region as a migratory route to Pomarine Skuas and the other two small skua species that frequent Irish waters on a seasonal basis.
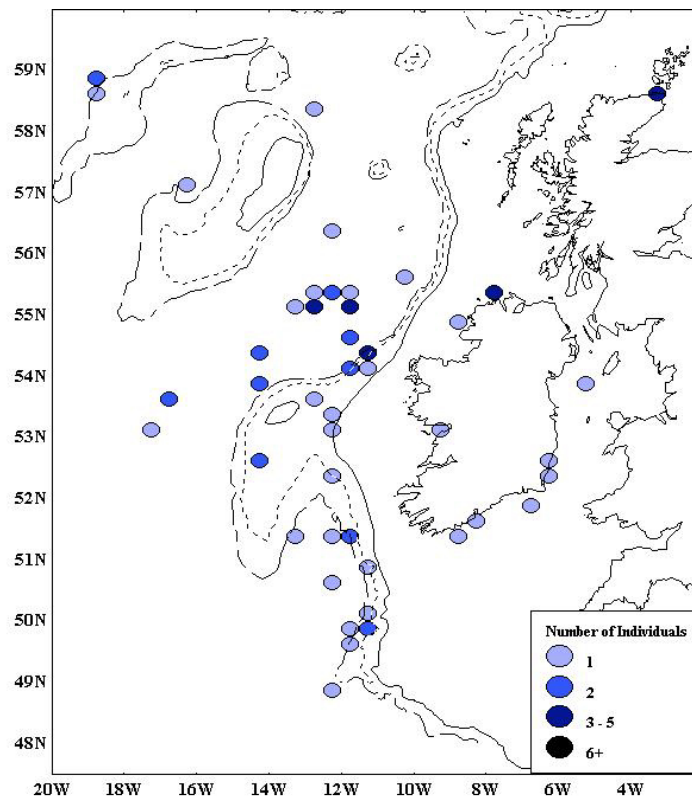
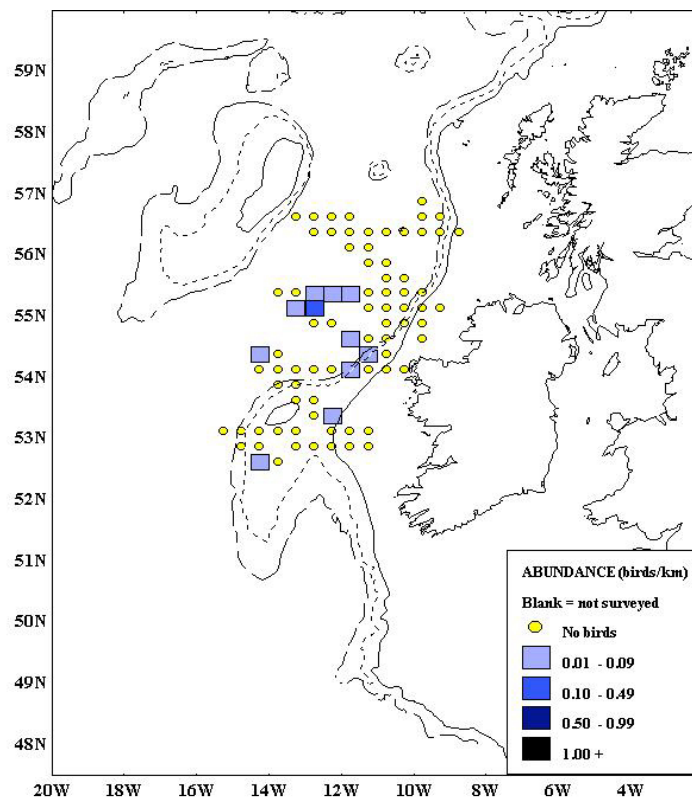Figure 1.39. Pomarine Skua sightings, July 1999–September 2001.

Figure 1.40. Pomarine Skua distribution during the *SIAR* survey,
August 2000.

Arctic Skua *Stercorarius parasiticus* (Vulnerability: Moderate)

The Arctic Skua (*a.k.a.* Parasitic Skua) is included in the British Red Data list of birds as a candidate species, requiring close monitoring of its status (Sears *et al.*, 1995). A medium-sized skua that breeds on the Western Isles, Orkney and Shetland, the Arctic Skua population appears to be suffering due to direct predation and competition for food from the expanding Great Skua population (Meek *et al.*, 1994; Thompson *et al.* 1997; Mead, 2000).

Arctic Skuas were observed in every season (Fig. 1.41). Birds observed in July and August were probably failed breeders on their southward migration to wintering grounds, off southwest Africa. The successful breeders follow these birds sometime between early August and late September (Furness, 1987), which accounts for the increase in observations noted in September-October. Birds observed in November may have been those birds breeding in higher latitudes (e.g. Norway). Arctic Skuas will often stop at coastal sites during migration to harass and steal food from aggregations of terns and small gulls (Furness, 1987).

Figure 1.41. Relative abundance of Arctic Skuas recorded in each month, July 1999–September 2001.

Coastal observations were recorded from the Irish Sea, Galway Bay, the Celtic Sea and Malin Shelf waters. Although this species is thought to remain in close association with continental coasts during migration, Arctic Skuas were encountered in low numbers throughout the offshore survey area (Fig. 1.42). Sightings were recorded from the Porcupine Seabight, the Porcupine Shelf, the Rockall Trough, the Rockall Bank and the Hatton Bank. The relatively high incidence of offshore sightings, particularly those over the Rockall and Hatton Banks, is of interest and worthy of further investigation. The results herein and from a recent survey (Mackey *et al.*, 2003) suggest that the Hatton-Rockall and Rockall Trough regions acts as important routes during both spring and autumn migrations.

Fifteen percent of the 88 individuals recorded throughout the survey were engaged in kleptoparasitic attacks on Black-legged Kittiwakes, juvenile Northern Gannets, Common Terns and, on one occasion, a Long-tailed Skua. Almost 70% of these attacks were observed in the months of May and June, indicating that this feeding strategy may be of greater importance during the spring return migration to breeding areas.
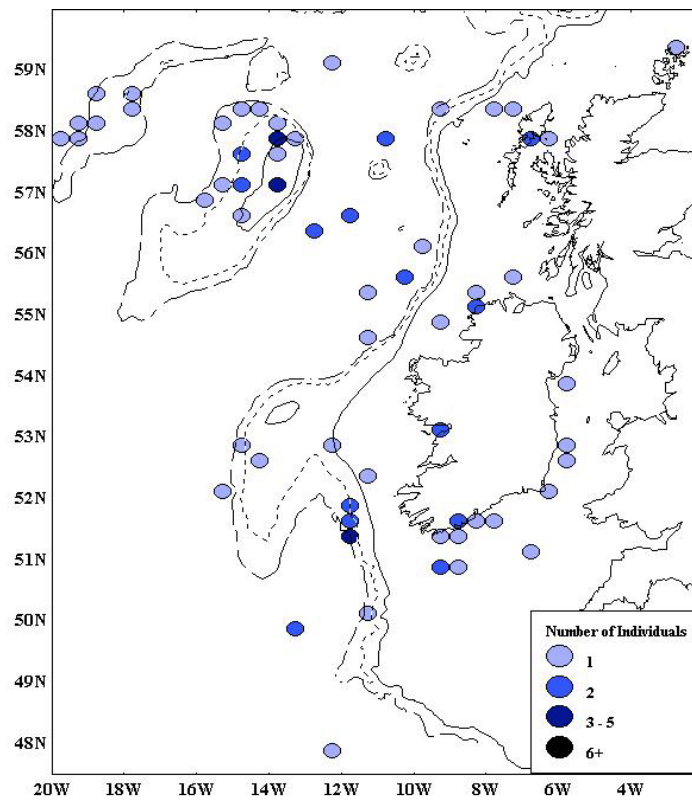
Figure 1.42. Arctic Skua sightings, July 1999–September 2001.

Long-tailed Skua *Stercorarius longicaudus* (Vulnerability: Moderate)
Twenty-seven Long-tailed Skuas were recorded throughout the survey period; 48% of all sightings occurred in May. This northern migrant was recorded in each of the five months between May and September (Fig. 1.43). The May-June peak is likely to be due to the northward spring migration of post-moult birds heading back to breeding areas after wintering off southwest Africa or southeastern South America (Furness, 1987).

Figure 1.43. Relative abundance of Long-tailed Skuas recorded in each month, July 1999–September 2001.

Mackey *et al.* (2003) recorded over 270 Long-tailed Skuas during a five-week survey of the Hatton-Rockall region during May 2002. As a result, the Hatton-Rockall Basin and, to a lesser extent, the region south of the Hatton Bank have been identified as important conduits for the Long-tailed Skua during the return migration. The main outward migration occurs in August although, in some years, Long-tailed Skuas may head south to the wintering grounds somewhat earlier (Furness, 1987). This may explain the recordings made in the month of July in the present study (Fig. 1.43).

Generally considered to be an arctic breeder, the Long-tailed Skua has occasionally been observed among Arctic Skua breeding colonies on mainland Scotland (Mead, 2000). During migrations, Long-tailed Skuas remain well away from coasts, except when unable to fly against storms (Furness, 1987). This migratory pattern is reflected in the distribution observed during this study, where this species was recorded as widespread over the offshore waters of the Rockall Trough, the Hatton and Rockall Banks and the edge of the Porcupine Seabight (Fig. 1.44). As observed for Arctic Skuas, the offshore waters of the Rockall Trough and surrounding areas appears to act as an important conduit for Long-tailed Skuas during the spring and autumn migrations. Long-tailed Skuas migrate quickly over offshore waters without feeding extensively, and are rarely observed attacking other seabirds while in transit (Furness, 1987). Only three Long-tailed Skuas were recorded undertaking kleptoparasitic attacks, these on Black-legged Kittiwakes during May and June. A juvenile Long-tailed Skua was itself the victim of a kleptoparasitic attack by a juvenile Arctic Skua.
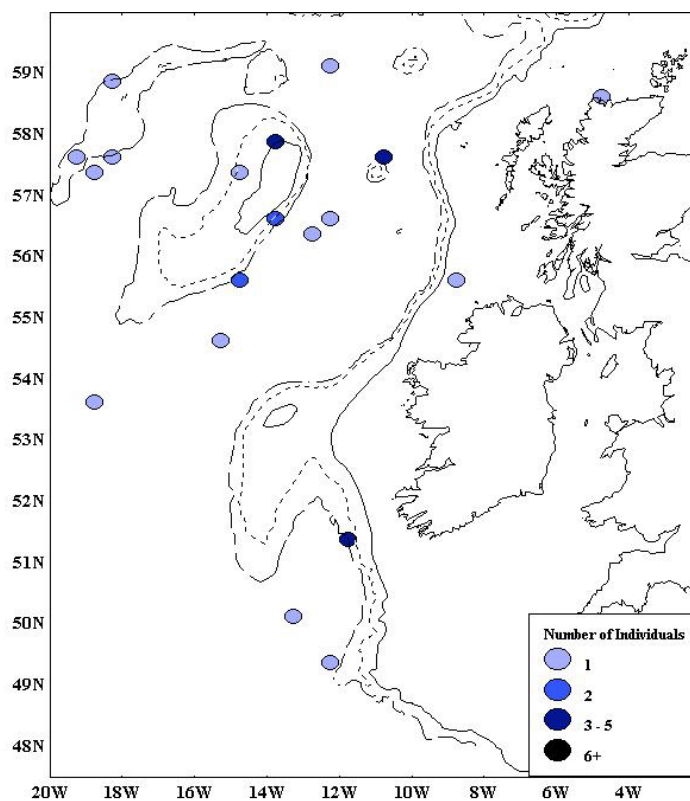

Figure 1.44. Long-tailed Skua sightings, July 1999–September 2001.

Black-headed Gull *Larus ridibundus* (Vulnerability: Moderate)

Local Black-headed Gull populations have been affected by mass mortality events attributed to botulism ingestion (Buckley & O'Halloran, 1986). The breeding success of this coastal species has also been compromised through predation by small carnivorous mammals, such as foxes, hedgehogs and mink (Craik, 1995; Mead, 2000). Despite these setbacks, the future of local Black-headed Gull populations does not appear to be threatened (Mead, 2000).

The Black-headed Gull was the most abundant inshore gull species recorded in the present study; the numbers recorded during full transect surveys totalled 5,008 birds. The majority of these, however, were recorded in a single large aggregation of gulls in Galway Bay in October 1999 (Fig. 1.45). Apart from this group, the species was infrequently recorded, and the only other substantial records in the present study were from the Dublin Bay in November 1999 and the Shannon Estuary in February 2000. Other records were widely distributed along the coast.

Figure 1.45. Black-headed Gull sightings, July 1999– September 2001.

Mew Gull *Larus canus* (Vulnerability: Moderate)

The Mew Gull (formerly known as the Common Gull) is a small coastal species, whose breeding success has been adversely affected by mammalian predation (Craik, 2000) and nest flooding (Whilde, 1984). Over 1,170 Mew Gulls were recorded; almost all occurred in large feeding aggregations in Galway Bay in October 1999 (Fig. 1.46). A small number of immature Mew Gulls were recorded in association with fishing vessels in deeper waters throughout the survey period.

Mediterranean Gull *Larus melanocephalus* (Vulnerability: U)

Three Mediterranean Gulls were recorded in the present study. A single Mediterranean Gull was seen outside Dún Laoghaire Harbour, County Dublin in November 1999, and a further two birds were recorded over shelf waters west of Galway Bay in September 2000. This species, which appears to be increasingly common in Ireland, was also recorded in small numbers by Pollock *et al*. (1997) in the English Channel and Irish Sea during the month of July.
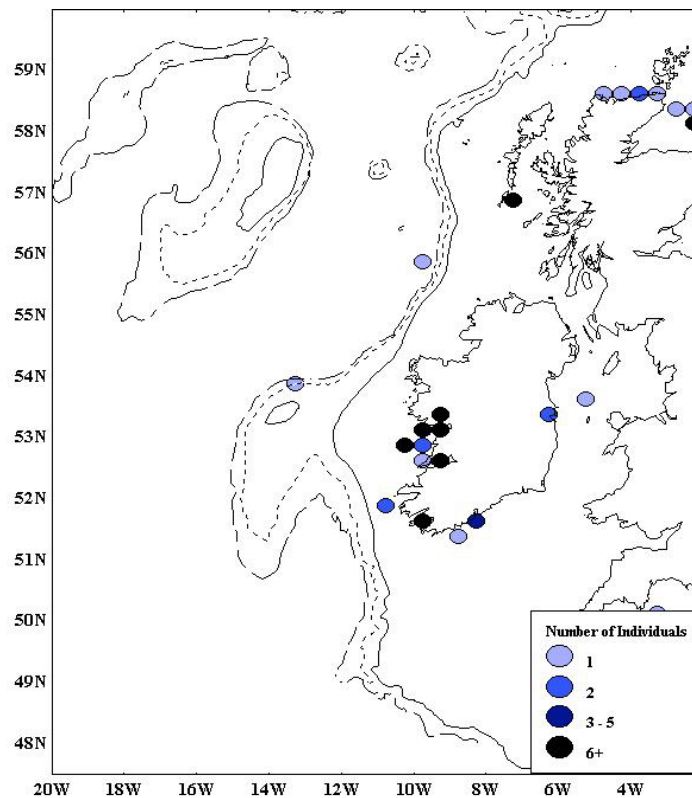
Figure 1.46. Mew Gull sightings, July 1999-September 2001.

Herring Gull *Larus argentatus* (Vulnerability: Moderate, P)
Although Irish coastal populations of Herring Gulls have decreased significantly since the late 1970s and early 1980s (Creme *et al.*, 1997), it remains the commonest of the three large gull species breeding in Britain and Ireland (Lloyd *et al.*, 1991). This reduction is believed to be due, in part, to the ingestion of the botulinum toxin (*Clostridium botulinum* Type C) (Quinn & Crinion, 1984; Buckley & O'Halloran, 1986). Similar reductions due to botulinum ingestion have also been observed among Herring Gulls on Skomer Island, Wales (Perrins & Smith, 2000).

Figure 1.47. Relative abundance of Herring Gulls recorded in each month, July 1999–September 2001.

For the most part, this urban gull was erratically encountered in inshore areas particularly during the months of January and February (Fig. 1.47) when offshore survey effort was limited. A total of 417 Herring Gulls were recorded while on survey, mostly in inshore waters (Fig. 1.48). The Herring Gull was relatively scarce compared to the other large *Larus* species (Lesser Black-backed and Great Black-backed Gulls) throughout the study period. Interestingly, there were some records from the Rockall and Hatton Banks in June 2000. Only 12 Herring Gulls were observed in association with fishing vessels.

Figure 1.48. Herring Gull sightings, July 1999-September 2001.

Iceland Gull *Larus glaucoides* (Vulnerability: U)
Two Iceland Gulls were observed in February 2000 over the deep waters of the northern Rockall Trough, while a single bird was recorded southeast of the Western Isles, Scotland during the same period. A single Iceland Gull (1st summer plumage) was also seen, when the observer was off-effort, near Clare Island (County Mayo) in August 2000.

Lesser Black-backed Gull *Larus fuscus* (Vulnerability: Moderate, P)
Legislative protection, increased foraging opportunities (e.g. on municipal landfills, fishing discards) and a significant decrease in local Herring Gull numbers all coincide with recorded increases in the numbers of Lesser Black-backed Gulls around Ireland (Lloyd *et al.*, 1991; Mead, 2000). Hagemeijer & Blair (1997) indicated that the recent increase in this species' overall breeding population and range might also have been influenced to a decrease in human disturbance (i.e. shooting and egg-taking). Mead (2000) subsequently suggested that there might be cause for serious concern with regional declines in population size and productivity. However, an increase of over 14% in the Irish breeding population has been observed, mainly along the south and southeast coasts, where the growing population of overwintering flocks are also concentrated (Creme *et al.*, 1997; Heath & Evans, 2000).

Seasonal Distribution

The Lesser Black-backed Gull (Plate 8) was detected during every month of the survey with a distinct peak in April (Fig. 1.49). Surprisingly, there were no obvious peaks during summer or autumn. Lesser Black-backed Gulls were very scarce at sea in winter and autumn (Fig. 1.50a & d) and many autumn records were closely associated with the southern Irish coastline. This is in agreement with the findings of Creme *et al.* (1997) who indicated that annual peak concentrations of this species might be found through southern Ireland in the months of November and December.

Figure 1.49. Relative abundance of Lesser Black-backed Gulls recorded in each month, July 1999–September 2001.

Plate 8. The Lesser Black-backed Gull was frequently encountered during their annual migrations between African wintering quarters and their European and Scandinavian breeding grounds.

Many of the spring records were widespread throughout the northern sector of the Rockall Trough and some birds had already reached the Rockall Bank (Fig. 1.50b), which suggests that the Rockall Trough area is an important route for this migratory gull. During spring, the Lesser Black-backed Gull was sparsely distributed in low concentrations over the Rockall and Hatton Banks, the Rockall Trough and along the slope of the Porcupine Seabight and Goban Spur (Fig. 1.50b). The offshore nature of the Lesser Black-backed Gull's distribution during spring and summer months (Figs. 1.50b & c) differs from the findings of Pollock *et al.* (1997) who reported a closer association with coastal waters.

As with other species in late summer, there is a distinct trend for the northwestern coasts to be vacated, coinciding with a general bird movement to the south. There were numerous sightings of small groups of Lesser Black-backed Gulls over the deep waters of the Rockall Trough in late summer (Fig. 1.50c). Most birds were adults flying southwest in pairs but several larger flocks including family parties were also seen.
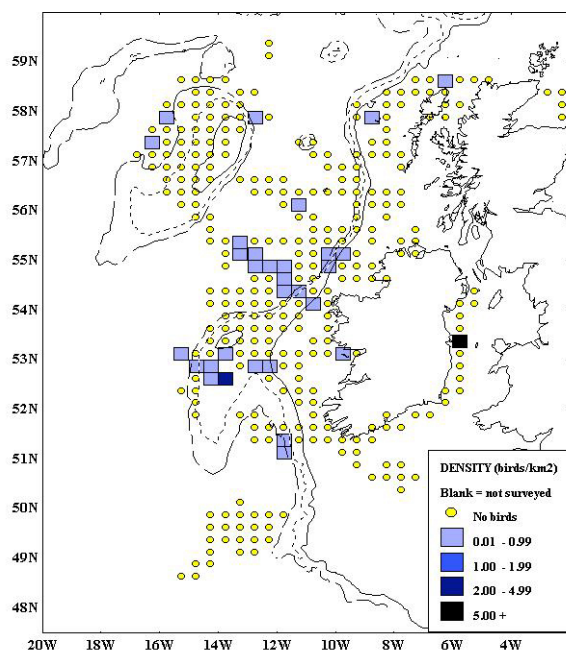
Due to the Lesser Black-backed Gull's habit of associating with survey ships, approximately 52% of sightings records had to be disregarded for density and relative abundance analyses; this represents the second highest rate of association for seabird species observed during the study (Table 1.3). A further 17.2% of sightings were recorded in association with fishing vessels, a habit also documented by other authors (Stone *et al.*, 1995; Oro & Ruiz, 1997; Walter & Becker, 1997; Pollock *et al.*, 2000). All Lesser Black-backed Gulls seen during this survey were of the race *L. fuscus graellsii*, which breeds in Britain, Ireland, Iceland, Netherlands, France, Scandinavia, Germany and the Faeroe Islands (Hagemeijer & Blair, 1997).
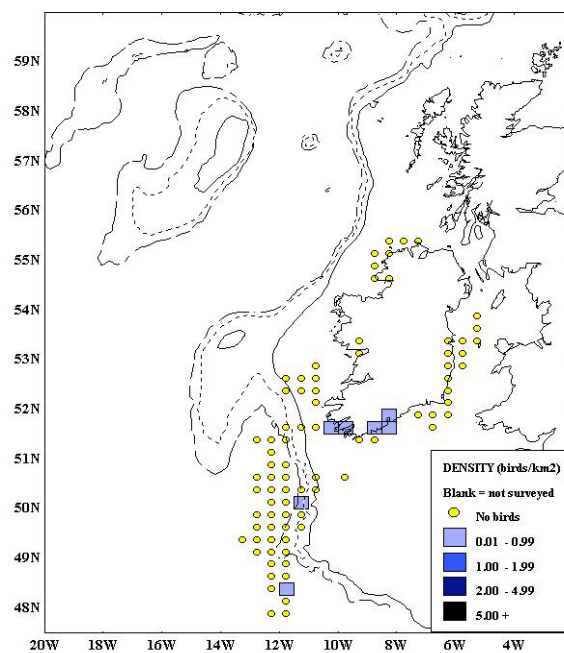
a) Winter

b) Spring

c) Summer

d) Autumn

Figure 1.50. Lesser Black-backed Gull densities, July 1999-September 2001.

Great Black-backed Gull *Larus marinus* (Vulnerability: Moderate, P)

It is generally agreed that the Great Black-backed Gull is a sedentary species that closely associates itself with coastal regions (Pollock *et al.*, 2000) and the results of the present study broadly support this conclusion. Indeed, it has been shown that rabbits, brown rats and terrestrial bird species (e.g. Hooded Crow, Chough, Jackdaw and Rock Pipit) can contribute a significant percentage of this predatory gull's diet (Hudson, 1982; Bullock *et al.*, 1983; Poole, 1995). The Great Black-backed Gull has also been identified as a formidable predator of small seabirds, particularly during the breeding season (Hudson, 1982). Species commonly targeted include Atlantic Puffins (Lockley, 1953; Harris, 1984a; Merne & Madden, 2002), Common Guillemots and Razorbills (Hudson, 1982), Black Guillemots (Asbirk, 1979), Black-legged Kittiwakes (Hudson, 1982) and Manx Shearwaters (Hudson, 1982; Poole, 1995).

In the present study, thirteen percent of all records of this species were observed in association with fishing vessels, reflecting Great Black-backed Gulls' well-documented scavenging habits and their common association with fishing vessels, where they commonly feed on discards (Lloyd *et al.*, 1991; Walter & Becker, 1997).

Great Black-backed Gulls were recorded in every month during the survey with a distinct peak in October (Fig. 1.51). The low numbers recorded between May and August may reflect its preference for in inshore waters adjacent to breeding colonies. Over 1,500 Great Black-backed Gulls were recorded during the study with highest densities in coastal waters (Fig. 1.52).
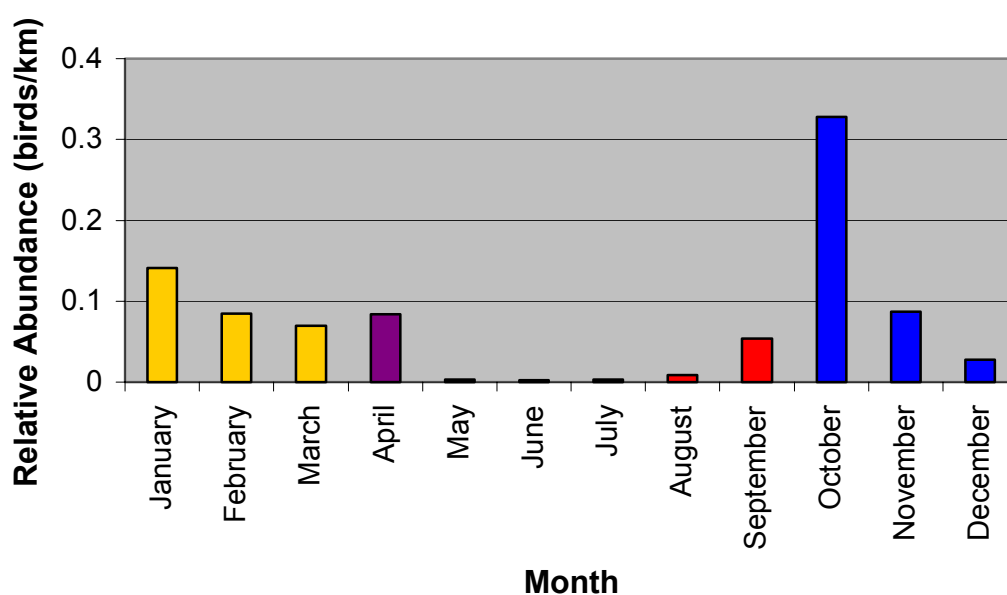

Figure 1.51. Relative abundance of Great Black-backed Gulls recorded in each month, July 1999–September 2001.

There is a broad similarity in the low encounter frequency and coastal distribution of the Great Black-backed Gull in spring (Fig. 1.52b), summer (Fig. 1.52c) and autumn (Fig. 1.52d). The species was effectively absent from the Rockall Trough, though there was one sighting in spring over the Hatton Bank (June, 2000). Sighting frequency increased during winter months (Fig. 1.52a) when survey effort concentrated over continental shelf waters to the west of Counties Mayo, Galway, Clare, Kerry and Cork (Fig. 1.4a).
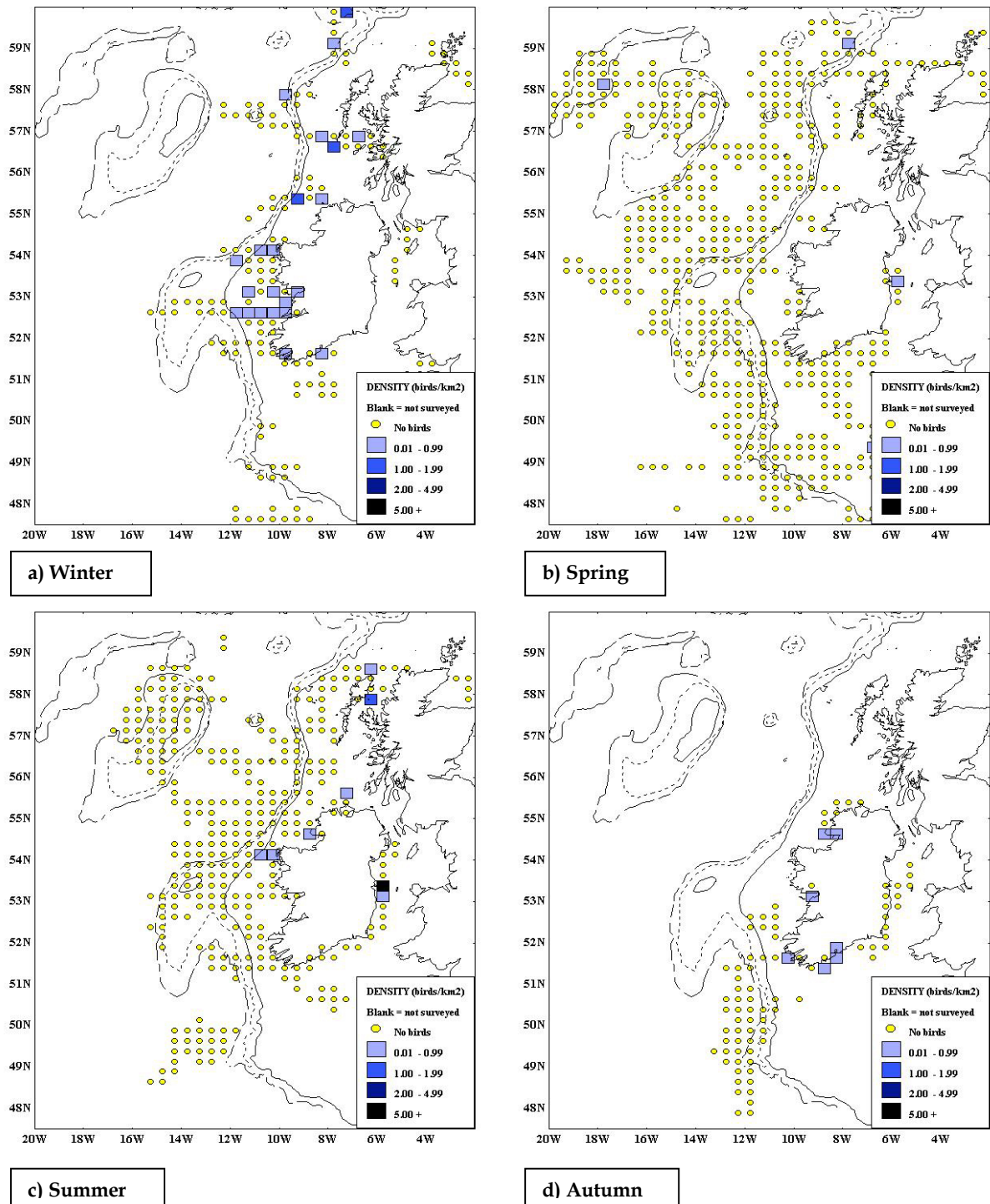
Figure 1.52. Great Black-backed Gull densities, July 1999–September 2001.

Little Gull *Larus minutus* (Vulnerability: U)

A total of 26 Little Gulls were recorded in coastal waters off Counties Wicklow (November 1999), Wexford (November 1999) and Galway (September 2000) (Fig. 1.53). A further 100 birds were recorded off the Lizard headland in Cornwall, in April 2001. The inshore distribution of this species observed in the present study probably reflects the Little Gull's preference for estuarine habitats during both autumn and spring migrations (Madden & Ruttledge, 1993; Skov *et al.*, 1995).
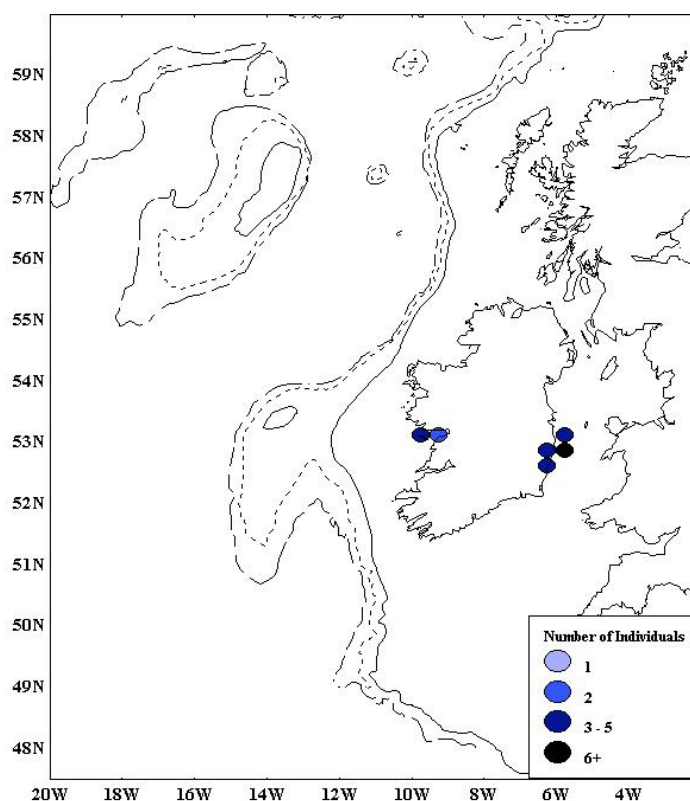
Figure 1.53.   Little Gull sightings, July 1999–September 2001.

Black-legged Kittiwake *Rissa tridactyla* (Vulnerability: High)

The Black-legged Kittiwake (Plate 9) is known to be one of the most pelagic of the gull species (Lloyd *et al.*, 1991) and was expected to be widely distributed within the Rockall Trough and associated survey areas. However, recent censuses of North Sea seabird colonies indicate that breeding populations of Black-legged Kittiwakes have been in serious decline (>50% reduction in some cases) over the past 15 years (Harris *et al.*, 2000; Heubeck, 2000). These observed reductions in breeding numbers of Black-legged Kittiwakes may be due to associated declines in sandeel stocks (Harris & Wanless, 1997; Tasker, 2000), together with increased predation by Great Skuas (Heubeck *et al.*, 1997; Heubeck, 2000; Mead, 2000) and terrestrial mammals (McGrath & Walsh, 1996), post-fledgling mortality and the emigration of young birds to other breeding sites (Thompson & Walsh, 2000). In spite of these trends, the Black-legged Kittiwake remains one of the most numerous seabird species breeding in Ireland (Hutchinson, 1989; Lloyd *et al.*, 1991; Pollock *et al.*, 1997).

Over 21% of Black-legged Kittiwake sighting records could not be used in density and relative abundance analysis due to the species' habit of associating with survey vessels for extended periods; Black-legged Kittiwakes demonstrated the fourth highest rate of association noted during the study. A further 6.2% of all sightings were recorded in association with fishing vessels.

Seasonal distribution

The Black-legged Kittiwake was the third most abundant seabird species recorded in the present study (>12,300 records), and the species was encountered in every month of the year (Fig. 1.54). Distinct peaks in abundance were noted in February (presumably birds returning to the colonies) and November (reflecting the existence of large flocks foraging in inshore waters). This coincided with relatively few birds recorded in the Porcupine Seabight/ Goban Spur during winter and autumn (Figs. 1.55a & d). Interestingly, the

Black-legged Kittiwake was widely distributed during spring along the slope of the continental shelf and over the Rockall Trough, the Hatton Bank and the Porcupine Bank/Seabight region (Fig. 1.55b). As breeding adults are busy incubating eggs at the colonies at this time, the offshore records were most likely immature non-breeding birds. With the exception of data from the Rockall and Hatton Banks, the results appear to be in general agreement with those of Pollock *et al.* (1997).
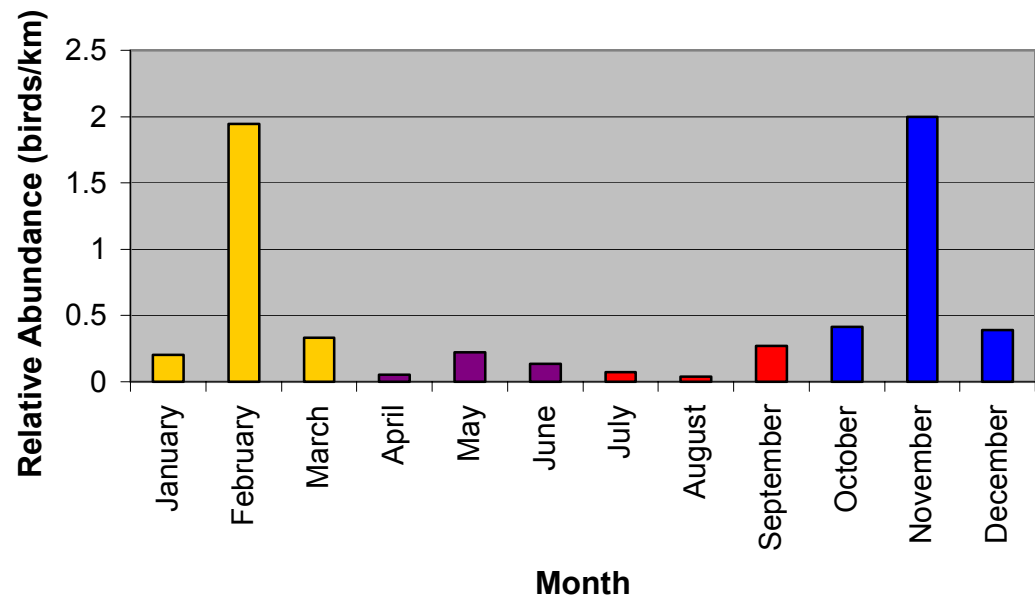
Figure 1.54. Relative abundance of Black-legged Kittiwakes recorded in each month, July 1999 – September 2001.

Plate 9. A partially oiled adult Black-legged Kittiwake in flight. Three oiled Black-legged Kittiwakes were encountered throughout the study period.

During summer months, the Black-legged Kittiwake was recorded in low to moderate concentrations over the Rockall Bank, the Rockall Trough and in coastal waters west and east of Ireland (Fig. 1.55c). Winter surveys concentrated on the shallower inshore waters of the western seaboard where the Black-legged Kittiwake was widespread and occasionally relatively numerous, particularly in the Shannon Estuary (Fig. 1.55a). However, in some offshore areas west of County Galway and County Mayo there were areas where Black-legged Kittiwakes were not recorded in winter. The species was also present over the northern sector of the Rockall Trough.
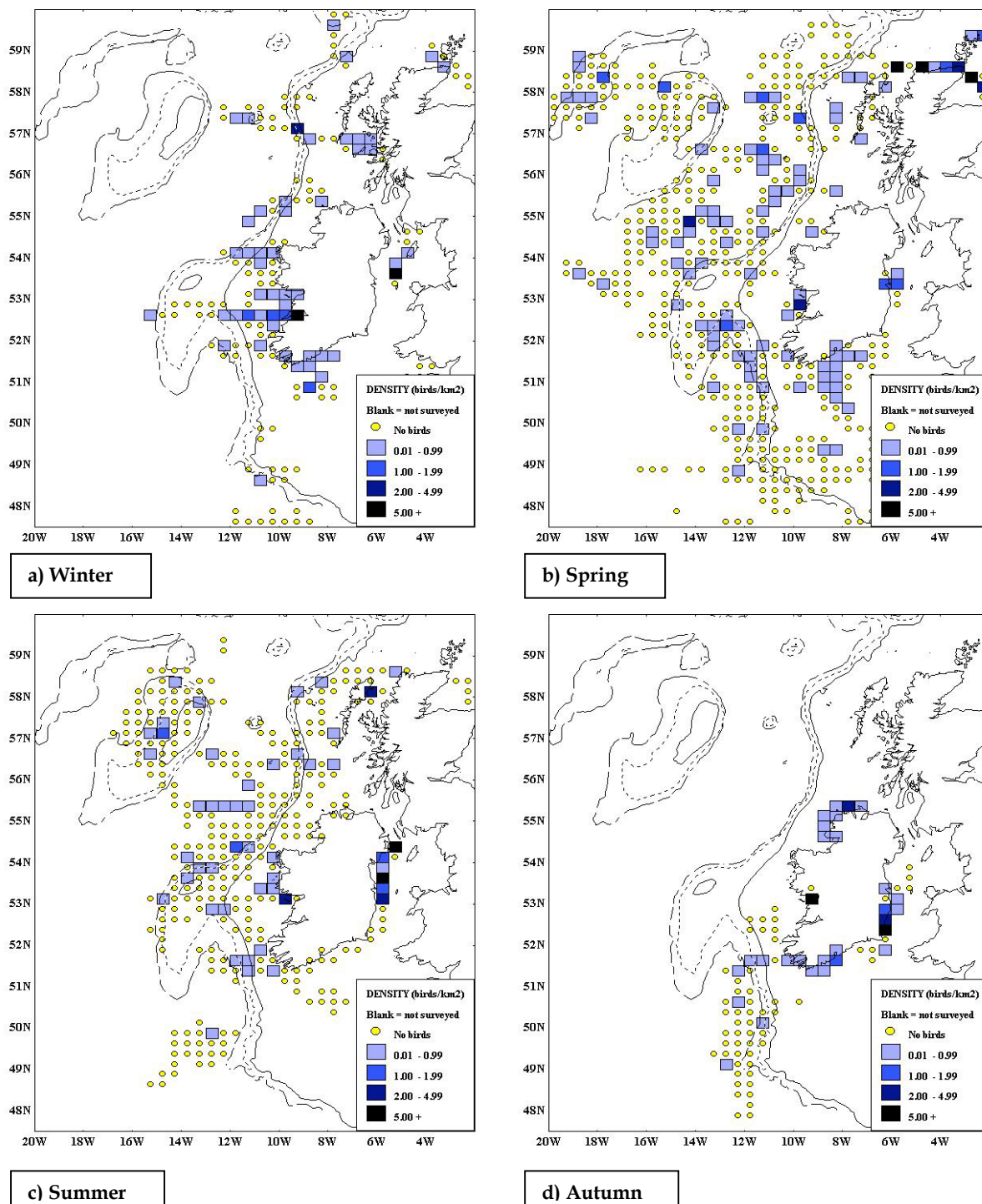

Figure 1.55. Black-legged Kittiwake seasonal densities, July 1999 – September 2001.

SIAR survey

The Black-legged Kittiwake was widely distributed in low to moderate concentrations during the *SIAR* survey (Fig. 1.56). This species was most frequently encountered over the deep waters of the Rockall Trough, west of County Donegal and along the continental slope. Moderate numbers Black-legged Kittiwakes were recorded over the Porcupine Bank and in association with the large feeding flocks of Manx Shearwaters recorded off Achill Island (County Mayo).
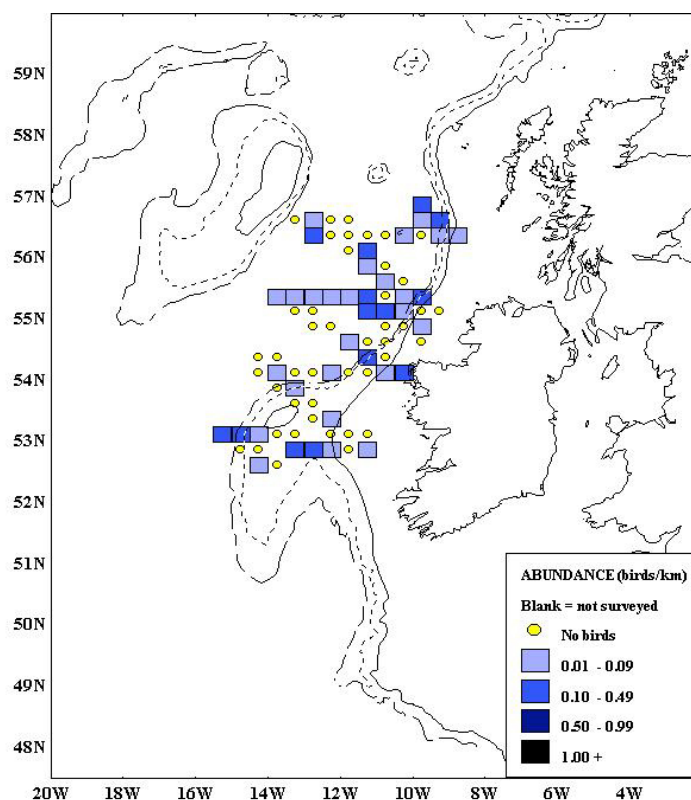

Figure 1.56.   Black-legged Kittiwake distribution during the *SIAR* survey, August 2000.

Sabine's Gull *Larus sabini* (Vulnerability: U)

Twelve Sabine's Gulls were recorded from five encounters (Fig. 1.57). Two birds were noted over the Rockall Bank in September 1999, while an adult-juvenile pair was recorded over the Hatton Bank in June 2000. This high Arctic breeder migrates southward through the northeast Atlantic in September and October and variable numbers occur in Irish waters at these times, depending on prevailing weather conditions (Svensson & Grant, 1999).

Sandwich Tern *Sterna sandvicensis* (Vulnerability: Moderate)

Sandwich Terns are listed in Annex 1 of the EU Birds Directive and are included on the Amber list of Birds of Conservation Concern. Declines in Sandwich Tern populations have been attributed, in part, to mammalian predation (Thompson *et al.*, 1996). Although brown rats may have adversely affected the productivity of Roseate Terns at Lady's Island Lake (County Wexford: Fig. 1.1), the Sandwich Tern displayed good productivity at the same site (Newton & Crowe, 2001). Two individual Sandwich Tern sightings were recorded outside of the study area close to Orkney (June 2001) and west of Spain (April 2001). Off-effort sightings of Sandwich Terns were recorded at Galway Harbour.
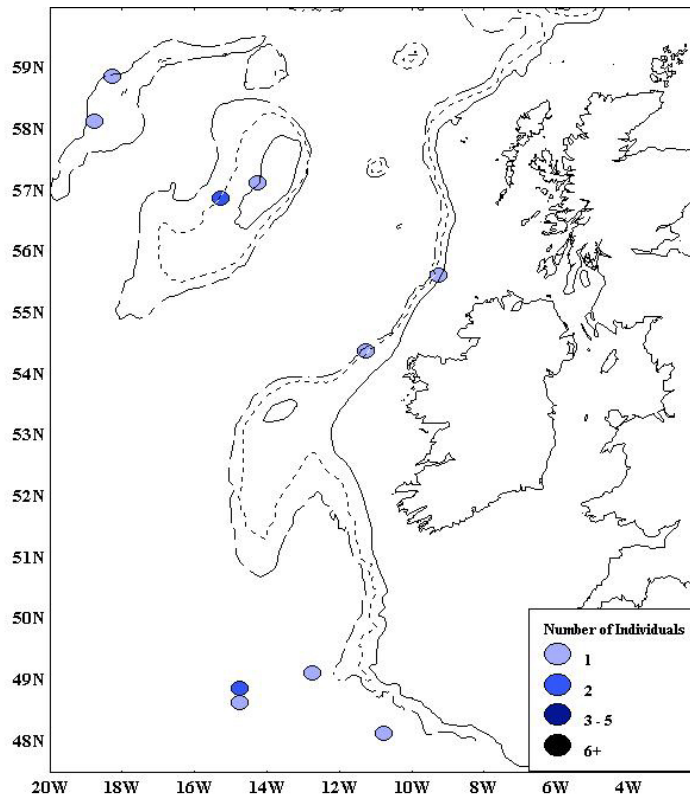
Figure 1.57. Sabine's Gull sightings, July 1999–September 2001.

Roseate Tern *Sterna dougallii* (Vulnerability: Very High P, R)
Roseate Terns are listed in Annex 1 of the EU Birds Directive and classified as SPEC 3 by BirdLife International due to their endangered status in Europe. Habitat erosion reduced a large colony of Roseate Terns in Wexford Harbour from 2,000 pairs in 1962 to 258 pairs in 1984 (Mead, 2000). Indeed, erosion has been identified as a key factor in recent declines in Irish Roseate Tern numbers (Casey *et al.*, 1995). The exclusion of unauthorized disturbance, the virtual elimination of predation by gulls, habitat extension and the recent provision of nesting boxes on Rockabill (County Dublin) and Lady's Island Lake (County Wexford) (Fig. 1.1) were highly successful in consolidating the population (Casey *et al.*, 1995; Mead, 2000). Despite these conservation measures, a slight decrease in overall Roseate Tern numbers was observed in Ireland in 2001 (Newton, 2001a). In the current survey, two Roseate Terns were recorded over the Celtic Sea, southeast of Ireland (May 2000), with another individual being observed west of Spain (April 2001).

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"Comm/ic" terns *Sterna hirunda/paradisaea*.
Common and Arctic Terns can be very difficult to distinguish in the field. As such, the term "comm/ic" has been created to describe those Common and Arctic Terns that cannot be accurately identified. All 36 comm/ic terns recorded throughout the survey were recorded between May and September.
- -

Common Tern *Sterna hirundo* (Vulnerability: Moderate)
The Common Tern is a summer visitor that breeds at coastal and inland locations (Lloyd *et al.*, 1991). A total of 50 Common Terns were noted at various offshore and coastal locations throughout the reporting period, between the months May and September (Fig. 1.58). Only 24% of Common Tern sightings were recorded over the offshore waters, west of 10˚W (Fig. 1.59). Over 91% of these offshore sightings were recorded in the months of May and June. Average to

good productivity ratings were assigned to Common Tern breeding colonies in County Dublin and County Wexford by Newton (2001a).
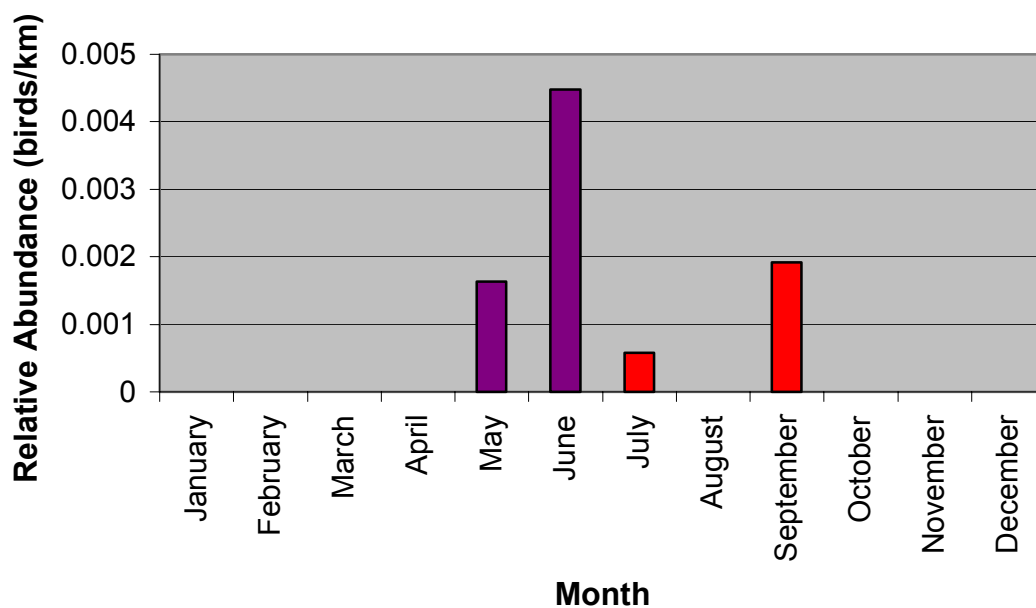

Figure 1.58. Relative abundance of Common Terns recorded in each month, July 1999–September 2001.
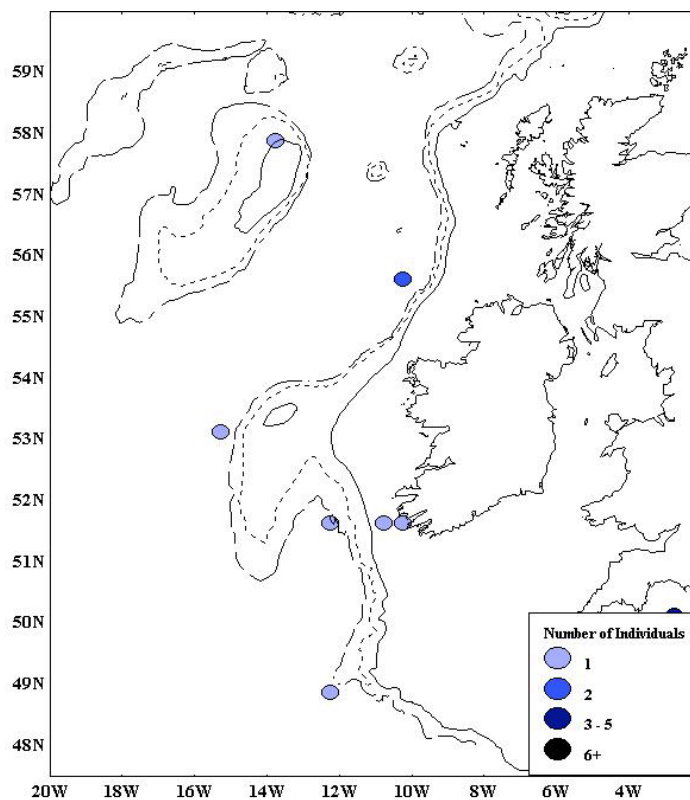

Figure 1.59. Common Tern sightings, July 1999–September 2001.

Arctic Tern *Sterna paradisaea* (Vulnerability: Moderate)

The Arctic Tern was the most commonly encountered tern species; 120 birds were recorded throughout the survey, outnumbering Common Tern records by approximately 2.5:1. It is likely that these were northern-breeding Arctic Terns on their southward migration. Twenty-seven of these birds were juveniles. Arctic Terns were recorded in five months, with over 67% observed in May and June (Fig. 1.60). A single bird was recorded in July.
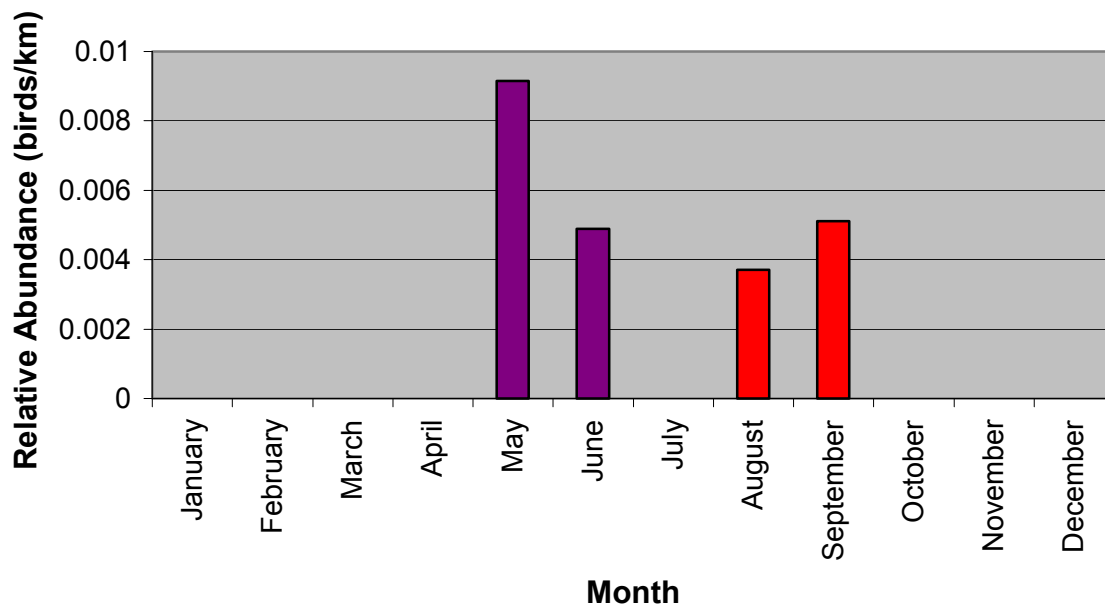

Figure 1.60. Relative abundance of Arctic Terns recorded in each month, July 1999–September 2001.
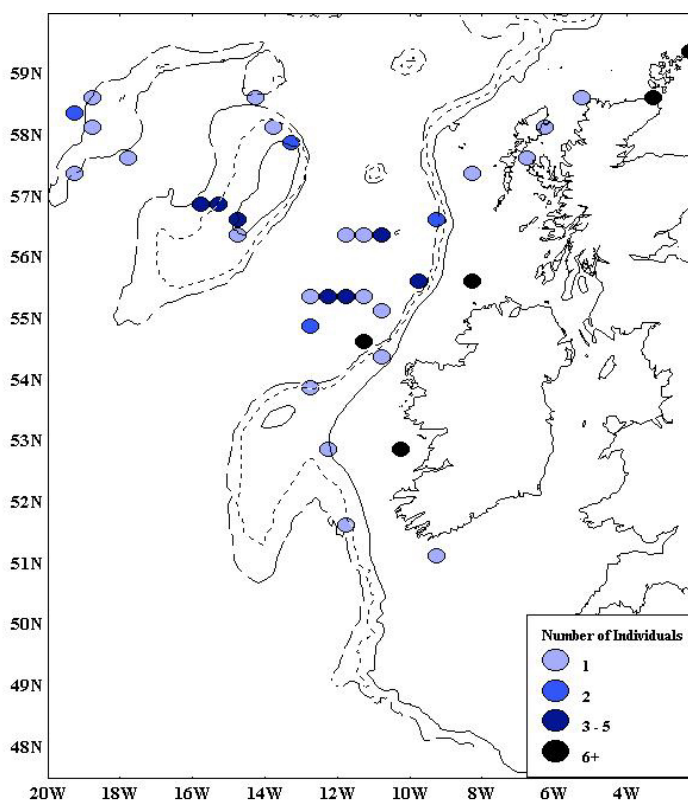

Figure 1.61. Arctic Tern sightings, July 1999–September 2001.

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This long-distance traveller is yet another seabird species that relies heavily on sandeel abundance to achieve relatively high reproductive success (Brindley *et al.*, 1999). The Arctic Tern is considered to be the most pelagic tern species in the North Sea (Camphuysen & Winter, 1996). The distribution pattern resulting from the current survey supports this view, with numerous sightings of Arctic Tern over the Rockall Trough and Rockall and Hatton Banks between May and September (*compare* Figs. 1.59 & 1.61). Over 67% of Arctic Tern sightings were recorded west of 10°W.

Little Tern *Sterna albifrons* (Vulnerability: U)
Little Terns are listed in Annex 1 of the EU Birds Directive and are included on the Amber list of Birds of Conservation Concern. An increase in Little Tern productivity was recorded at Kilcoole (County Wicklow) in 2001, following a period of predation by hedgehogs, which limited the population to 20 pairs (Newton, 2001a). Observers in the present study recorded two birds in coastal waters north of the Orkney Islands, Scotland in May 2001.

Black Guillemot *Cepphus grylle* (Vulnerability: Very high W, P)
Black Guillemot populations have been shown to be very susceptible to oil pollution events (Heubeck, 2000). Black Guillemots remain closely associated with coastal waters where they feed in shallow waters on small fish species, crustaceans, molluscs, worms and seaweed (Cramp *et al.*, 1974). Ten Black Guillemots were seen while on survey, all of which were encountered inshore along the west and north coasts of Ireland. As is the case with all coastal seabirds, numbers of this highly vulnerable species recorded in the present study are underestimated due to the project's focus on offshore areas.

Common Guillemot *Uria aalge* (Vulnerability: Very high W, P)
The Common Guillemots Guillemot is the largest of the four auk species breeding in Ireland and one of the most abundant seabird species breeding along the southwest Irish coast (Moore *et al.*, 1997). An important breeding colony for the European Common Guillemot population is located at Lambay Island, County Dublin (Merne & Madden, 1999), while important colonies for Irish and British populations are located at the Great Saltee, County Wexford and the Cliffs of Moher, County Clare (Fig. 1.1) (Boelens *et al.*, 1999).
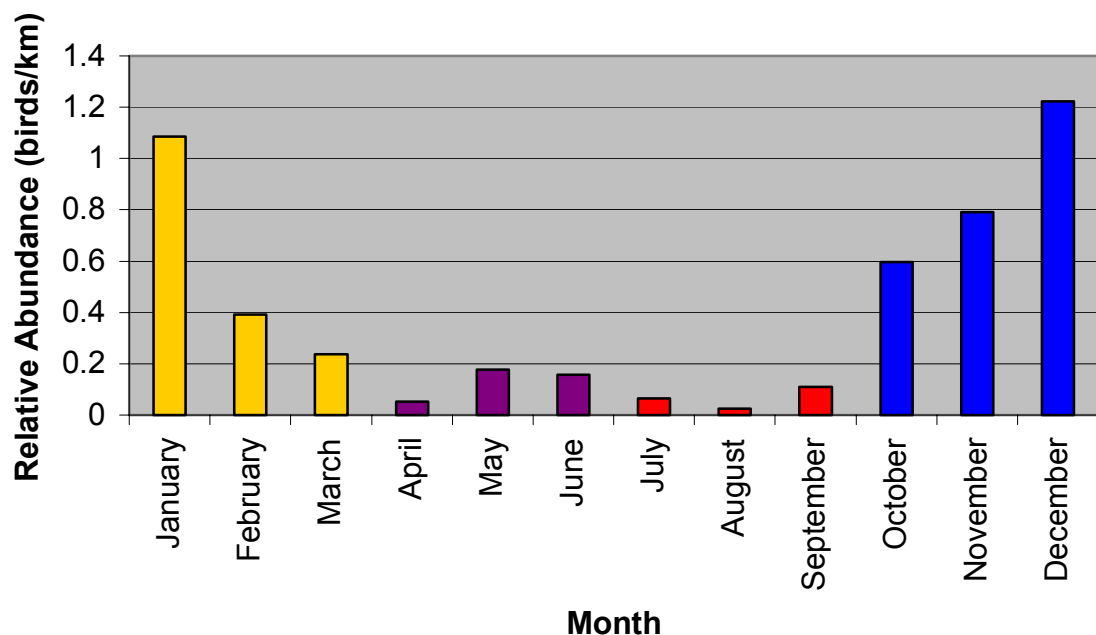

Figure 1.62. Relative abundance of Common Guillemots recorded in each month, July 1999–September 2001.
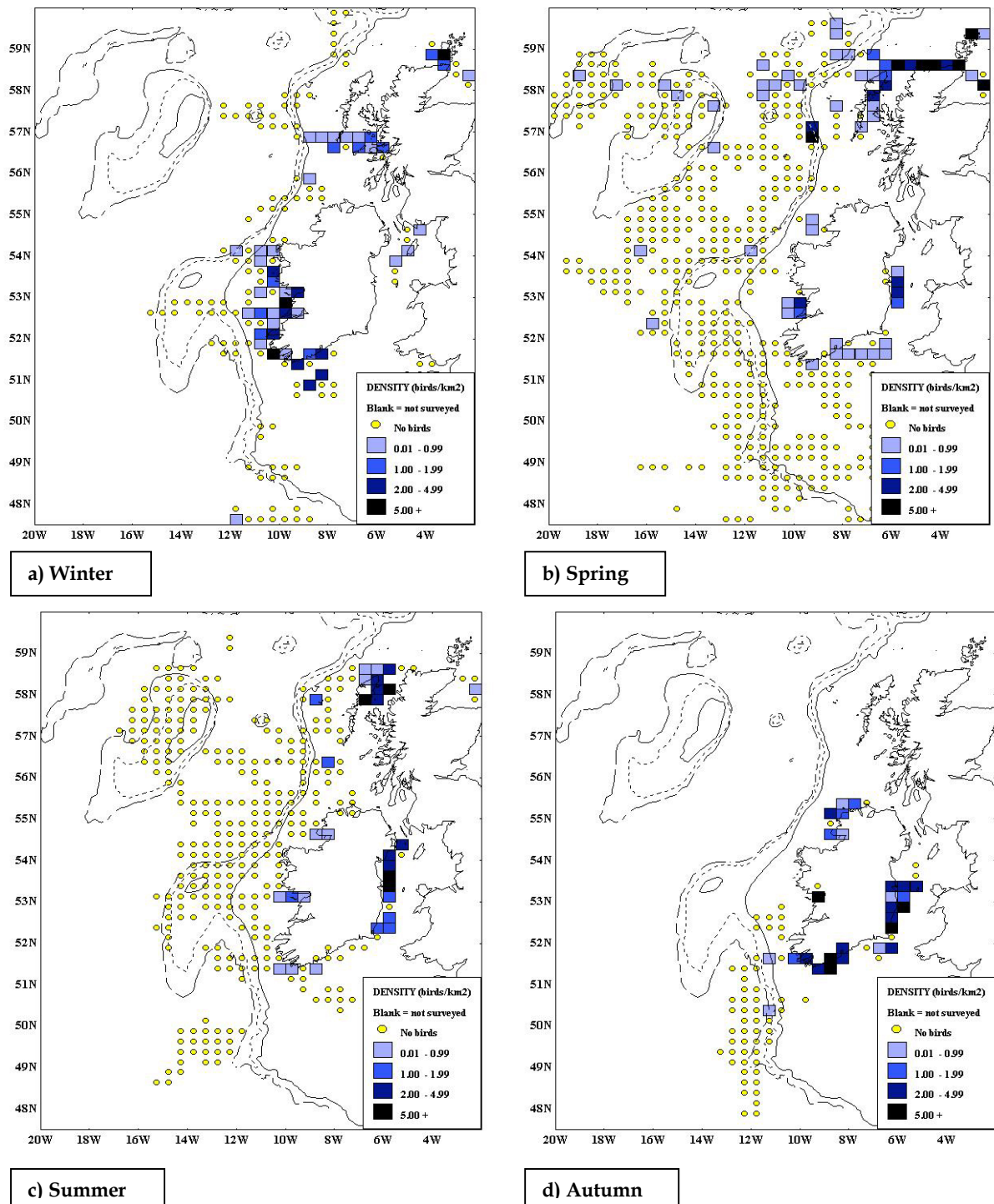
Figure 1.63. Common Guillemot densities, July 1999–September 2001.

Significant populations also breed on the Bull and Cow Rocks (County Cork) and on Skellig Michael and the Little Skellig, County Kerry (Fig. 1.1) (Moore *et al.*, 1997).

The distribution of Common Guillemots at sea is heavily influenced by prey distribution (e.g. sandeel, capelin, sprat, euphausiids), distance from colony and colony location (Harris, 1970; Wright & Begg, 1997; Mehlum, 2001). Like all auk species, Common Guillemots are very susceptible to any water-borne pollution incidents (Cramp *et al.*, 1974; Williams *et al.*, 1994; Heubeck, 2000; Camphuysen *et al.*, 2002), particularly after the breeding season when large concentrations gather to undergo a total flight-feather moult (Skov *et al.*, 1995; Webb *et al.*, 1995).

The moult period can last several weeks, during which the birds are rendered completely flightless (Birkhead & Taylor, 1977).

The Common Guillemot was the most commonly sighted auk species recorded on-effort; 6,086 birds were recorded in total. The species was recorded throughout Ireland's Atlantic Margin in every month of the year with distinct peaks in January and December (Fig. 1.62). These seasonal peaks in abundance and distribution are strongly influenced by sightings of large concentrations of Common Guillemots in inshore continental shelf waters during winter and autumn months (Figs. 1.63a & d). However, due to the limitations in offshore survey effort during these months (Figs. 1.4a & d), care must be taken in the interpretation of these data as a reflection of the species' true distribution and abundance within Ireland's Atlantic Margin. Autumn concentrations in the Irish Sea accounted for many of these birds (Fig. 1.63d). Conversely, the low abundances registered between April and September (Fig. 1.62) reflect the skewed level of offshore effort, where Common Guillemot sightings were limited.

It is important to note that while Common Guillemots were virtually absent from deep offshore areas throughout the year, although this species was recorded in low densities in deep water; low concentrations were observed over the northern sector of the Rockall Trough and the western Porcupine Shelf between April and June (Fig. 1.63b). Occasional sightings were also recorded as far west as the Rockall and Hatton Banks during May and June (Fig. 1.63b). High to moderate densities were recorded in the region of the Lambay Island colony during the moult period together with moderate densities of moulting Razorbills (Figs. 1.63c & 1.65c). Low to moderate concentrations of Common Guillemots were also noted through the Minch and north of the Hebrides during the same period.

Although many of the post-moult flocks generally disperse offshore from October (Pollock *et al.*, 2000), high to moderate concentrations of Common Guillemot were still being recorded in inshore regions of Cork Harbour, Galway Bay, Dublin Bay, Wicklow Head and Carnsore Point, County Wexford during the autumn (Fig. 1.63d). High to moderate densities were also recorded during winter months around the Bull Rock, County Cork, in Galway Bay, in Dingle Bay, County Kerry, and in the vicinity of the important breeding colony at the Cliffs of Moher (Fig. 1.63a).

Brünnich's Guillemot *Uria lomvia* (Vulnerability: U)
The major European breeding grounds of this species are found in Iceland, Bear Island, Svalbard, Franz Josef Land and Novaya Zemlya (Hagemeijer & Blair, 1997), where they feed on capelin, sandeel and euphausiids (Lilliendahl & Solmundsson, 1997; Mehlum, 2001). Records of immature birds from low-Arctic waters have been recorded (Pollock *et al.*, 2000). Taylor & Reid (2001) reported limited records (i.e. four birds) close to the Faroe Islands during January, July and August. During the current study, individual Brünnich's Guillemots were observed sitting on the sea surface over the Hatton Bank (ca. 700-800m depth; ca. 58.5°N, 18.0°W) in late May and early June 2000.

Razorbill *Alca torda*   (Vulnerability: Very high W, P)
Important colonies for breeding Irish and British Razorbill populations are located at the Great Saltee in County Wexford, the Cliffs of Moher in County Clare and Horn Head in County Donegal (Fig. 1.1) (Lloyd *et al.*, 1991; Boelens *et al.*, 1999). Sizeable numbers of this species can also be found on Skellig Michael, County Kerry (Moore *et al.*, 1997; Heath & Evans, 2000). The growth recorded in a few colonies along the east coast (e.g. Lambay Island, County Dublin: Merne & Madden, 1999) may have compensated for the decline in Razorbill numbers observed along the south and west coast of Ireland (Lloyd *et al.*, 1991).

There were no records of Razorbills during December, despite the fact that peak abundances were recorded in November with relatively moderate concentrations being recorded in January and February (Fig. 1.64). This suggests that the absence of records in December is due to a combination of reduced sampling effort and sampling error. As was noted for Common Guillemots, the peaks recorded during autumn-winter refer to moderate-high concentrations recorded in inshore waters (Figs. 1.65a & d), and are an artifact of limited opportunities to survey offshore seabird populations between the months of October and March (Figs. 1.4a & d). Conversely, the lower relative abundances of Razorbills recorded between the months of April and October (Fig. 1.64) probably reflect a greater level of survey effort further from shore, resulting in fewer sightings (Figs. 1.65b & c).
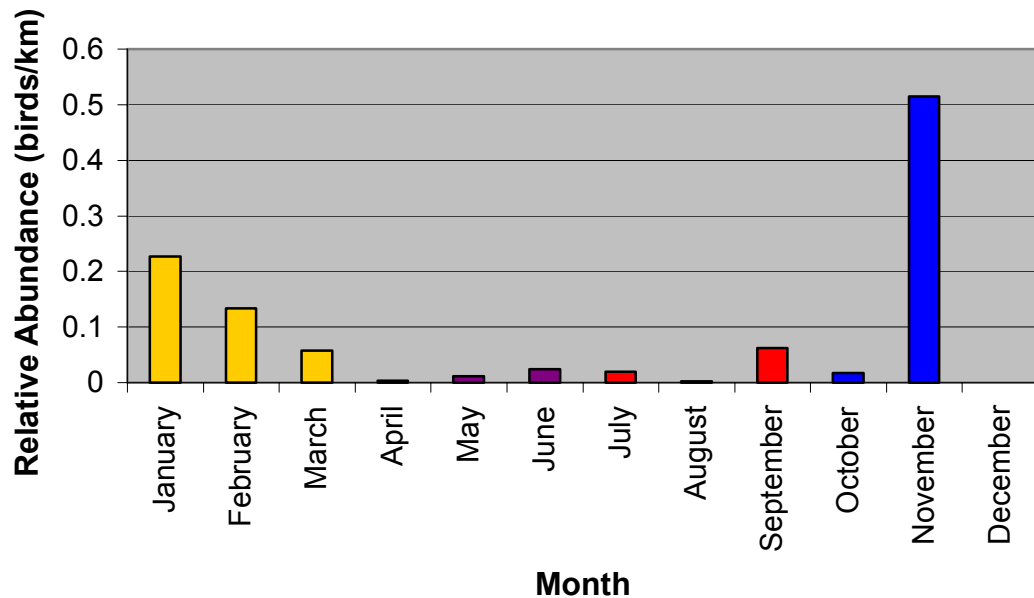

Figure 1.64. Relative abundance of Razorbills recorded in each month, July 1999–September 2001.

A total of 1,458 Razorbills were recorded in the present study with most birds sighted over continental shelf waters, relatively close to the coast (Fig. 1.65). Isolated offshore sightings of Razorbills were recorded during the spring over the northern sector of the Rockall Trough (April), along the continental slope west of Scotland and northwest of County Mayo in June (Fig. 1.65b). Additional offshore sightings were recorded over the Rockall and Hatton Banks in June 2000.

Coastal spring concentrations of Razorbills were closely associated with the Scottish breeding colonies of Cape Wrath/Clo Mor, the North Caithness cliffs, and to a lesser extent the Shiant Islands, St. Kilda and Westray (Fig. 1.65b). Lower densities were observed near the Irish breeding sites of Lambay Island, Great Saltee and off the Cliffs of Moher (Fig. 1.65b). Summer records of Razorbills were limited and appeared to be restricted to coastal and shelf regions (Fig. 1.65c).

Concentrations of Razorbills increased slightly in the Irish Sea during October and November (Fig. 1.65d), close to the Lambay Island and Great Saltee breeding colonies. Low numbers of Razorbills were observed near the Horn Head breeding colony during the same period. Southerly movements of Razorbill from breeding colonies in Scotland may have also influenced this autumnal increase. Winter observations were limited to low to moderate densities along the west and southwest coast of Ireland (Fig. 1.65a). Isolated records of Razorbills in winter were

also obtained over the north Irish Sea, south of the Orkney Islands and west of the island of Mull, in the Inner Hebrides.
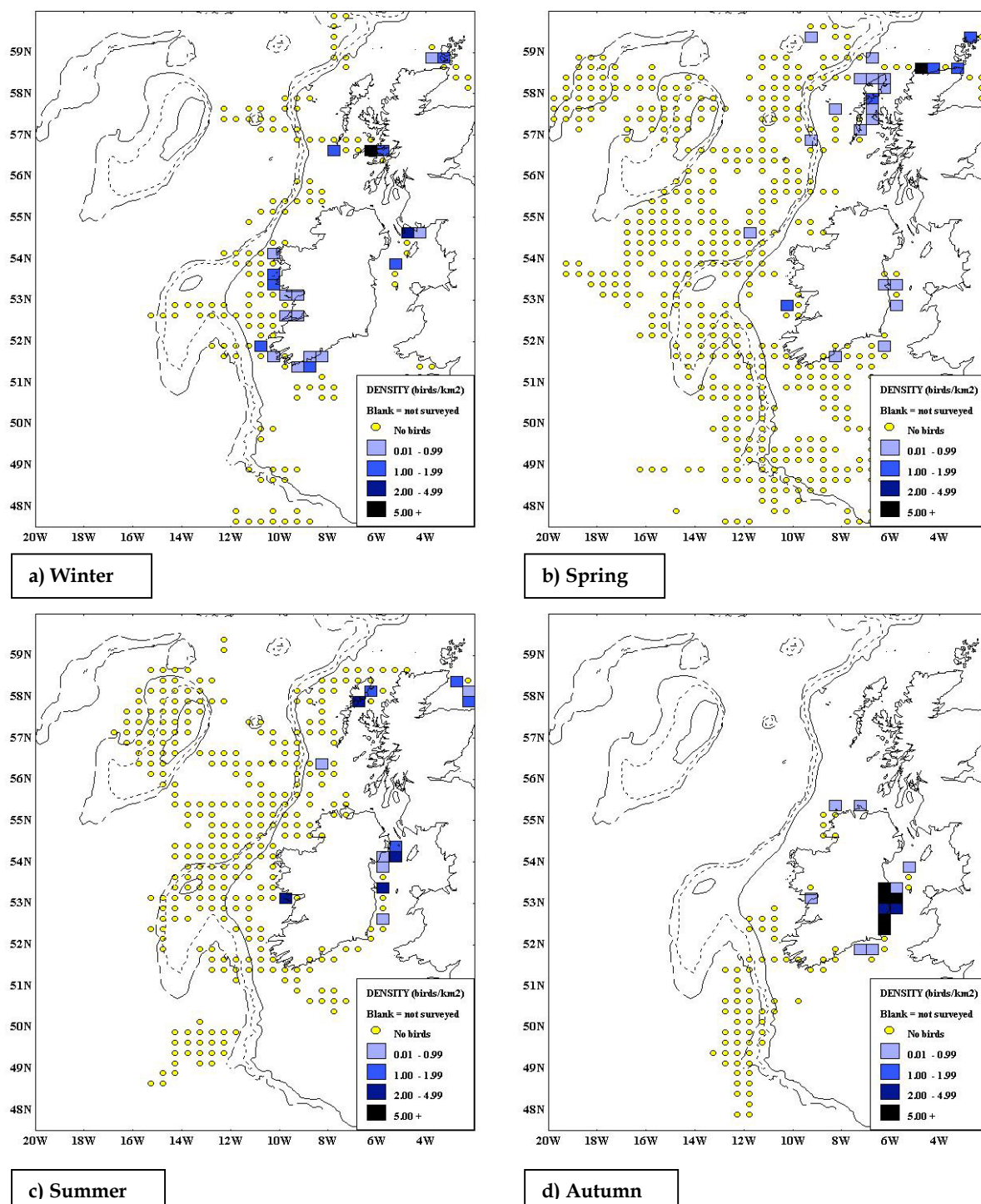

Figure 1.65. Razorbill densities, July 1999–September 2001.

Little Auk *Alle alle* (Vulnerability: High W)

Possibly the most difficult seabird to observe on the sea surface, the Little Auk was recorded on four occasions to the west of the Scottish Western Isles in February 2000, and once in waters overlying the Hatton Bank in May 2000 (Fig. 1.66). Fourteen Little Auks were observed in total, during eight encounters. Subsequent to the offshore fieldwork, large movements of Little Auks were observed in November 2001 from land-based sites in County Galway and County Mayo. This high arctic breeder will be regularly encountered off northwest Europe as it disperses southward during winter (Hagemeijer & Blair, 1997).
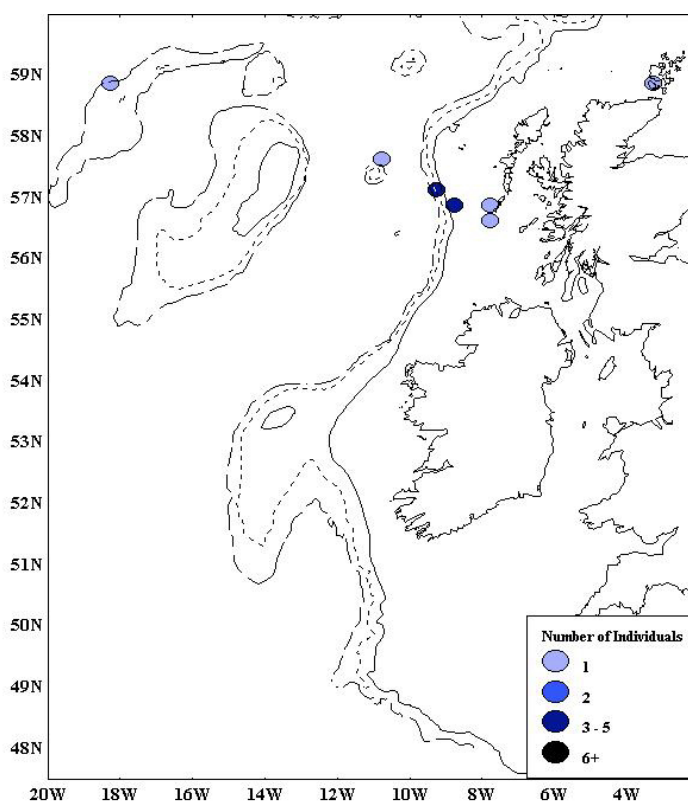
Figure 1.66. Little Auk sightings, July 1999–September 2001.

Atlantic Puffin *Fratercula arctica* (Vulnerability: Very high W, P)

The majority of the Atlantic Puffin population (Plate 10) breeds in Iceland and Norway (Hagemeijer & Blair, 1997). Other colonies exist on the mainland and offshore islands of Scotland, on the Faeroe Islands, in Ireland, England, Wales, France and the Channel Islands (Harris, 1984a). One colony that is thought to host more than 1% of the UK and Irish Atlantic Puffin population is the aptly named Puffin Island off County Kerry (Fig. 1.1) (Boelens *et al.*, 1999). Other Irish colonies with significant breeding numbers of Atlantic Puffins are the islands of Inishtearaght and Skellig Michael off County Kerry (Moore *et al.*, 1997), the Cliffs of Moher in County Clare, Illaunmaistir and Bills Rock off County Mayo, the Great Saltee off County Wexford, and Tory Island off County Donegal (Harris, 1984a; Lloyd *et al.*, 1991). Although Irish populations may have decreased at some of the southern (Mead, 2000) and eastern (Merne & Madden, 1999; Merne & Madden, 2002) colonies in recent decades, survival rates at various Scottish breeding sites have remained high (Harris *et al.*, 2000) and in some cases breeding numbers have increased (Murray, 1995).
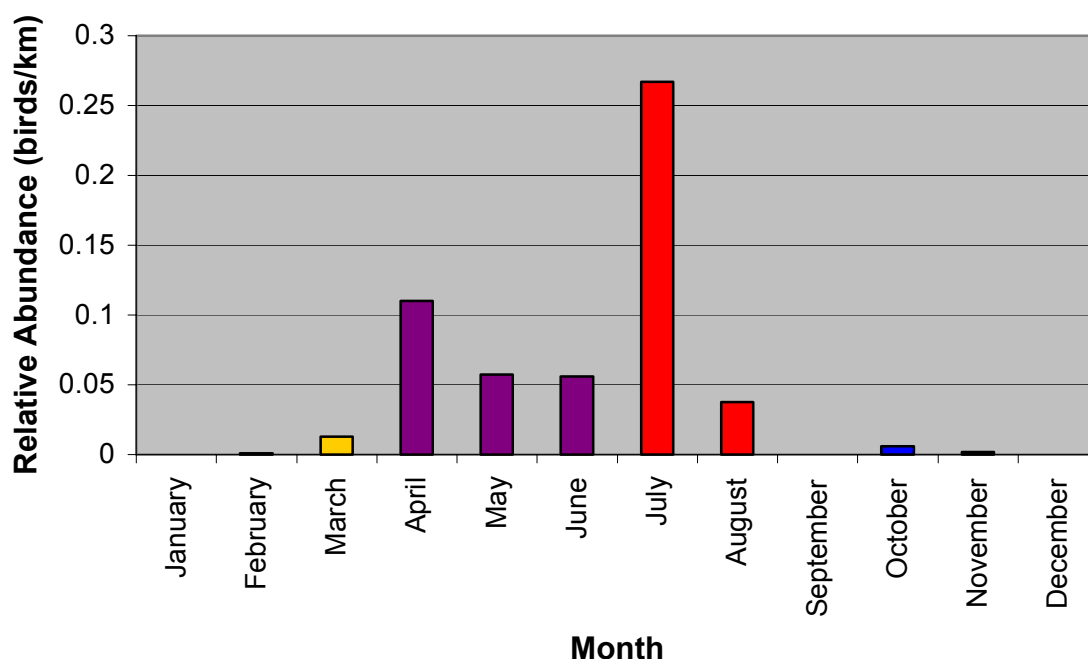
Figure 1.67. Relative abundance of Atlantic Puffins recorded in each month, July 1999–September 2001.

Seasonal distribution

The Atlantic Puffin was the second most frequently encountered auk throughout the survey, where it was recorded between the months of February and November (Fig. 1.67). Relatively low abundances were recorded in February, October and November. The trend in relative abundance is almost exactly the opposite of that recorded for Common Guillemots (Fig. 1.62) and Razorbills (Fig. 1.64), which reflects a more pelagic existence by Atlantic Puffins along Ireland's Atlantic Margin.

Most Atlantic Puffins probably winter at sea, although their exact distribution is poorly known (Harris, 1984a; Webb *et al.*, 1995; Camphuysen *et al.*, 2002). Unfortunately, the lack of substantial effort achieved during winter months restricted the chance of contributing to the understanding of this particular subject. Low winter concentrations were recorded along the coast of County Galway and close to the colonies of Mingulay and Berneray in the Sea of the Hebrides (Fig. 1.68a). Pollock *et al.* (1997) generally found Atlantic Puffins to the southwest of Ireland in the months of November and December.

As would be expected, the Atlantic Puffin is very abundant in the waters off its breeding strongholds in Scotland during the spring and summer (Figs. 1.68b & c). Figures 1.68b and 1.68c also highlight the Atlantic Puffin's relatively pelagic existence, with low to moderate densities recorded throughout the length of the Rockall Trough. It was also widely recorded in low concentrations over the Rockall and Hatton Banks during the same period (Figs. 1.68b & c).
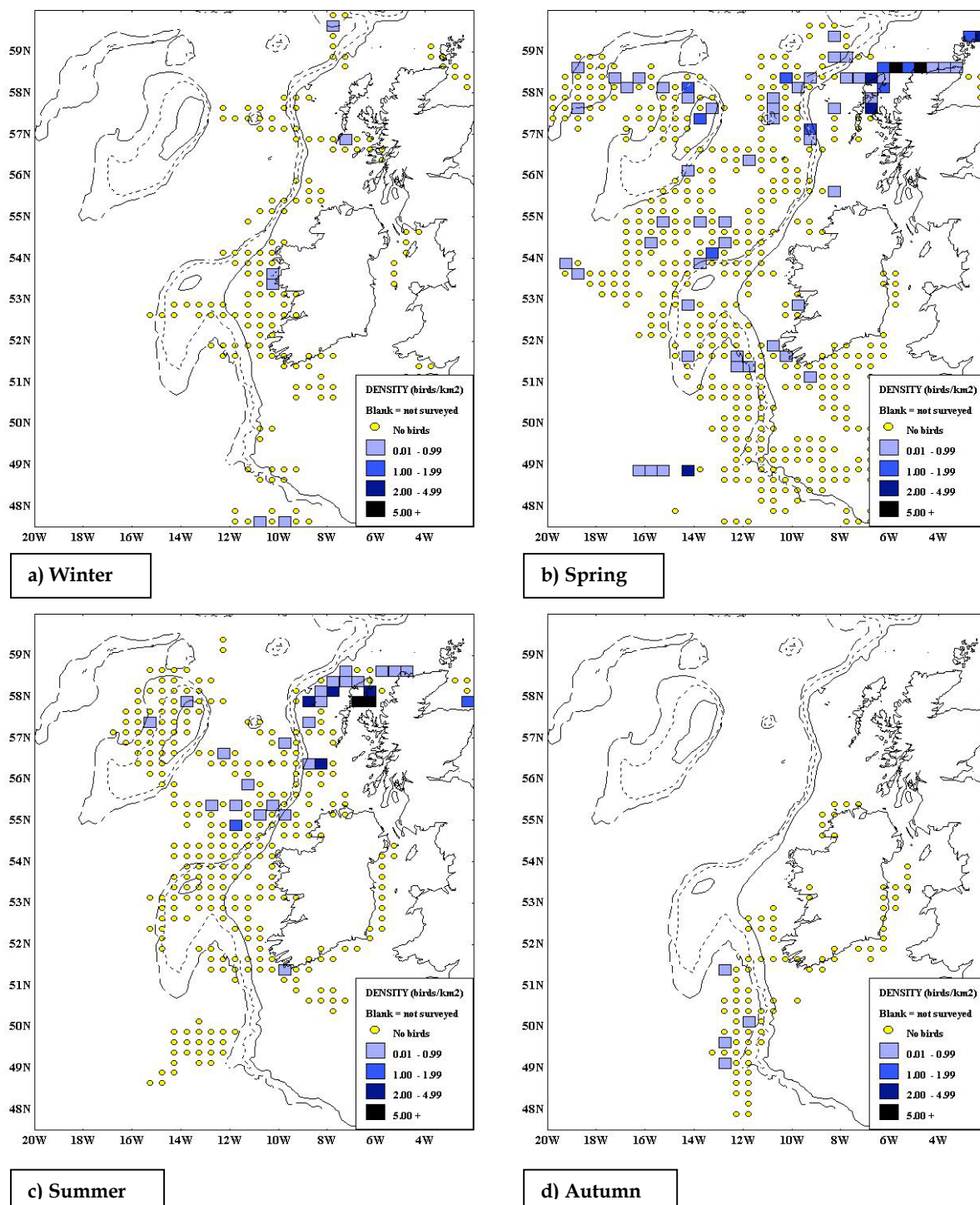
Figure 1.68. Atlantic Puffin seasonal densities, July 1999–September 2001.

A distinct northerly bias in the distribution of Atlantic Puffins was noted in summer, which is surprising in view of ringing recovery data, which indicates the opposite scenario (Harris, 1984a; Harris, 1984b). Atlantic Puffins were not recorded from the southern Rockall Trough and were sparsely distributed in the Celtic Sea in summer (Fig. 1.68c). The spasmodic sightings of approximately 200 immature birds and 11 adults, flying over the deep water west of the Goban Spur during early April 2001 (Fig. 1.68b) were of particular interest. Approximately 87% of the immature birds (with dark facial patches) were flying south or southwest. When sitting on the ocean's surface, juveniles, immature Atlantic Puffins were generally visible mainly only in relatively calm conditions (i.e. force 0-1).

Only ten Atlantic Puffins were observed during the autumn months; five birds over the deep water of the Porcupine Basin, west of the Goban Spur, in October-November (Fig. 1.68d) and a further five birds over the shelf waters, west of the Dingle Peninsula, in late October. These data are in broad agreement with the findings of Pollock *et al.* (1997).

Plate 10. The Atlantic Puffin was the most pelagic auk species recorded during the study.

CONCLUSION

Although much is now known of the numerical strengths of the various cliff-breeding populations of seabirds (burrowing species excepted) on our western seaboard, relatively little is known of their distribution and abundance at sea. The objective of the current survey was to map the distribution and abundance of seabirds in the deeper waters, particularly the Rockall Trough, off the contiguous coasts of Ireland. The results of this survey therefore, represent a considerable westerly and northwesterly extension of existing knowledge on the distribution and abundance of seabirds in the eastern North Atlantic.

A total of five seabird orders were recorded including divers and one species of scoter. The Order Charadriiformes (n = 36 species; ca. 64% of the total number of species recorded, including waders, skuas, gulls, terns and auks) contained most species within the overall survey, followed by the Procellariiformes (n = 10 species; ca. 18%) and Pelecaniformes (n = 3 species; ca. 5%). However, when the most frequently encountered species, particularly those recorded in deeper waters, are considered (Table 1.3) then a more even distribution of species between the Orders (note that divers, ducks and waders are not in this category) is evident, though the Charadriiformes remain the most diverse group. Overall, five species dominated the survey, namely Northern Fulmar, Northern Gannet, Black-legged Kittiwake, Common Guillemot and Manx Shearwater.

Moreover, if the mainly inshore species such as the Common Guillemot are removed then only four species are dominant, though the Great Shearwater now becomes one of the most frequently encountered seabirds in the present study. It is interesting to note that both the European Storm-petrel and Atlantic Puffin appeared to be relatively scarce throughout Ireland's Atlantic Margin, in spite of the presence of important breeding colonies along the Atlantic seaboard. Difficulties in detection may explain the relatively low abundances of both these species and it is considered that alternative methods for surveying such relatively inconspicuous species should be explored.

It is informative to look at the species composition by Order and to consider these data in relation to season:

1. ORDER Procellariiformes
- **Family *Procellariidae* – The Shearwaters**
Four species of shearwater were recorded along Ireland's Atlantic Margin, of which the Manx Shearwater was the most abundant. However, a surprisingly large number of Great Shearwaters were encountered, but only over a period of four months. Nevertheless, the Manx Shearwater was less than twice as abundant as the Great Shearwater. This overall ratio (ca. 1.6:1) between the Manx Shearwater, which breeds in large numbers in Ireland, the Great Shearwater, a relatively scarce migrant (at least to inshore waters), is unexpected and deserves further investigation. This survey's data points to a possible major change in the status of the Great Shearwater (*see* Pollock *et al.,* 1997).

In August 2001, there was a major incursion of Sooty Shearwaters over the Rockall Bank. This and previous invasions of Cory's Shearwater emphasise the potential for large scale invasions of shearwaters and other pelagic seabirds (e.g. Leach's Storm-petrel), and this episodic behaviour should be viewed in the context of possible hydrocarbon pollution events.

- **Family *Hydrobatidae* – The Storm petrels**
Three species of storm petrel were recorded, of which the European Storm-petrel was the most abundant. While the overwhelming majority of sightings involved the European Storm-petrel,

Leach's and Wilson's Storm-petrels accounted for 7.7% of all storm petrel sightings. Twenty-eight petrels recorded at sea could not be identified to species level. Both the relatively low abundance of Leach' Storm-petrels and the relatively high percentage of Wilson's Storm-petrels are unexpected findings. Leach's Storm-petrels breed in Ireland, but Wilson's Storm-petrel breeds in the southern hemisphere and may be more common in the deeper offshore waters than was previously supposed. Remarkably, equal numbers of Leach's and Wilson's Storm-petrels were recorded during spring, and during this period the European Storm-petrel outnumbered the Wilson's Storm-petrel by a ratio of only 13:1. While there is no obvious explanation for this finding, it is possible that the Wilson's Storm-petrel may be relatively more abundant (*compare with* Stone *et al.,* 1995; Pollock *et al.,* 1997).

Finally, it would appear that the ratio of relative abundance of Northern Fulmars, Manx Shearwaters and European Storm-petrels, as discovered in this survey, is the opposite to their numerical abundance at breeding colonies along the Atlantic seaboard (Pollock *et al.,* 1997; Pollock *et al.,* 2000).

2. ORDER Charadriiformes

- **Family *Stercorariidae* – The Skuas**

A total of 1,016 skuas were recorded during this study, of which 81.9% were Great Skuas. Arctic Skuas formed 8.7% of the total and Pomarine Skuas 6.8%. Remarkably, Long-tailed Skuas constituted almost 3% of the total number of this family recorded. Again, there are two surprising features to this distribution: (i) the relatively low number of Arctic Skuas, which may be a function of their apparent preference for a migration route through coastal and inshore waters. However, a historical analysis of sightings from Cape Clear Island suggest that this species may have undergone a decline (Kelly & Haseldine, in prep.); (ii) the number of Pomarine and Long-tailed Skuas is perhaps higher than expected, though the latter species, in particular, is increasingly recorded from mainland sea-watching points.

- **Family *Laridae* – The Gulls**

One of the most notable features was the relatively low numbers of Herring Gulls observed during the study. Herring Gulls were outnumbered by Lesser Black-backed Gulls by a ratio of over 10:1. This confirms the now well-established trend in the decline of the Herring Gull and the apparent increase in Lesser Black-backed Gull numbers. An interesting movement of Lesser Black-backed Gull through the Rockall Trough was discovered during this survey. These individuals are almost certainly coming from the Icelandic breeding population, which is known to be increasing (Hagemeijer & Blair, 1997). The Black-legged Kittiwake was the third most commonly encountered species throughout the survey, while Great Black-backed Gull, Black-headed Gull and Mew Gull sightings were generally restricted to coastal regions.

- **Family *Sterninae* – The Terns**

Five species of tern were positively identified during this study. In general, tern sightings were scarce, with 330 records (including 36 "commic tern" and 117 unidentified tern sightings). Sandwich Tern, Roseate Tern, Little Tern, Common Tern and Arctic Tern were identified, with Arctic Terns outnumbering Common Terns by a ratio of approximately 2.5:1. The relatively low encounter rate of terns during this survey suggests that the offshore waters of Ireland's Atlantic Margin are relatively unimportant for this threatened and vulnerable seabird group, with the possible exception of the Arctic Tern.

- **Family *Alcidae* – The Auks**

Although relatively large numbers of Common Guillemots and Razorbills were recorded during the study, it is obvious that they are largely confined to shallow inshore and shelf waters, where their vulnerability to hydrocarbon pollution events is very high (Camphuysen *et al.,* 2002), particularly during the moult period (July–August). The Atlantic Puffin was the

second most common auk species, and unlike the two previously mentioned species, was commonly found in low to medium concentrations in the deeper waters of the Rockall Trough, Porcupine Seabight and Goban Spur.

Conclusions from the study may be summarised as follows:

1. This study is perhaps the most extensive to have been carried out to date of seabird populations of the offshore continental shelf and slope areas to the west of Ireland, the Rockall Trough, Porcupine Bank, Porcupine Seabight, Goban Spur, Rockall Bank, and Hatton Bank.

2. Due to unavoidable variation in survey effort, both in terms of the duration of surveys and also in the geographical areas covered, the data collected are incomplete with respect to season. This is particularly the case for the months between October and March.

3. A total of 37 seabird species were recorded during the survey. As a proportion of individuals within particular groups could not be identified with certainty (e.g. the terns and storm petrels), a figure of approximately 40 species is more likely for the waters of Ireland's Atlantic Margin.

4. The Rockall Trough appears to act as a conduit through which species, such as Lesser Black-backed Gulls, Pomarine and Long-tailed Skuas, move during their autumn and spring migrations between southern wintering and northern breeding grounds.

5. The Rockall Trough and the associated waters over the Rockall Bank, continental shelf, Porcupine Shelf and Porcupine Seabight may represent important feeding grounds for long-distance migratory species, such as the Great Shearwater and Sooty Shearwater between July and November.

6. The Hatton Bank and Hatton-Rockall Basin also appear to be of importance to migratory species, and together with the Rockall Bank may be of importance to those species that winter offshore, such as the Atlantic Puffin. One question that arises is whether both areas represent a pooling of the Icelandic, Faeroese and Scottish biogeographic zones or whether the region is exclusively utilised by Icelandic seabird populations. More work is required on this topic.

7. In order to interpret the results in a wider context and provide a more effective management tool, a future analytical objective of the CMRC *Cetaceans & Seabirds at Sea* programme would be to integrate seabird data with fisheries data and various physical and oceanographic parameters, such as bathymetry, seabed composition, sea surface temperature, salinity and geo-magnetic parameters. The scope of the present study did not cover these aspects. In this regard, the CMRC has good working relationships with several other institutions in Ireland (e.g. Marine Institute, Geological Survey of Ireland) and elsewhere (e.g. Southampton Oceanographic Centre, Norwegian Institute of Marine Research) which also have expertise in these fields and it would be extremely useful to conduct the kind of detailed analysis necessary, should the opportunity arise.

8. Priority research areas for the future also include the development of improved methods for the detection of inconspicuous species (e.g. storm petrels), the relative importance of offshore habitats for each age class within species (e.g. Northern Gannet, Black-legged Kittiwake), research to improve knowledge on key foraging zones for pelagic species

and furthering the knowledge of rare species occurring along the Irish Atlantic Margin (e.g. Wilson's Storm-petrels) and their relationship to climate change.

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Appendix A: Offshore survey programme, July 1999–September 2001.

Survey Dates	Vessel Name	Host Organisation	Vessel Activity	Main Location
05/07/99 – 26/07/99	M.V. *Bucentaur*	British Geological Survey, Edinburgh	Deep Coring	Porcupine Seabight
09/08/99 – 18/08/99	M.V. *Pelagia*	Netherlands Institute of Sea Research (NIOZ)	2D Seismic	North Porcupine Basin
27/08/99 – 07/09/99	F.R.V. *Scotia*	FRS, Aberdeen	Trawling Survey	Rockall Bank
23/09/99 – 30/09/99	L.E. *Eithne*	Irish Naval Service	Fisheries Patrol	Western and Eastern Ireland
18/10/99 – 05/11/99	L.E. *Eithne*	Irish Naval Service	Fisheries Patrol	Western and Eastern Ireland
23/11/99 – 10/12/99	L.E. *Eithne*	Irish Naval Service	Fisheries Patrol	Southern and Southeastern Ireland
03/01/00 – 08/01/00	L.E. *Eithne*	Irish Naval Service	Fisheries Patrol	Western Irish Shelf
27/01/00 – 20/02/00	R.R.S. *Discovery*	Southampton Oceanographic Centre/ DML	Oceanographic	Rockall-Iceland
16/02/00 – 08/03/00	M.V. *Scotian Shore*	Fugro GEOS	Oceanographic	Porcupine Basin
07/04/00 – 17/04/00	R.V. *Johan Hjort*	Institute of Marine Research, Bergen	Fisheries Research	Rockall Bank
20/04/00 – 03/05/00	R.R.S *Charles Darwin*	Southampton Oceanographic Centre	Oceanographic	Rockall Trough
09/05/00 – 11/05/00	L.E. *Eithne*	Irish Naval Service	Fisheries Patrol	Irish Sea
22/05/00 – 25/05/00	L.E. *Eithne*	Irish Naval Service	Fisheries Patrol	Porcupine Seabight
25/05/00 – 11/07/00	R.V. *Colonel Templer*	British Geological Survey, Edinburgh	2D Seismic	Hatton & Rockall Banks
09/06/00 – 28/06/00	R.V. *Belgica*	University of Gent	Benthic Biology/ 2D Seismic	Porcupine Basin
31/07/00 – 22/08/00	M.V. *Emerald Dawn*	University College Cork	Cetacean/Seabird Survey	Rockall Trough/ Porcupine Basin
12/09/00 – 18/09/00	S.V. *Siren*	Geological Survey of Ireland	Multibeam/ Side-Scan Sonar	Western Irish Shelf
18/09/00 – 28/09/00	L.E. *Eithne*	Irish Naval Service	Fisheries Patrol	Southwestern Irish Shelf
05/10/00 – 24/10/00	S.V. *Bligh*	Geological Survey of Ireland	Multibeam/ S-S Sonar	Goban Spur/ Celtic Basin
14/11/00 – 26/11/00	S.V. *Bligh*	Geological Survey of Ireland	Multibeam/ S-S Sonar	Goban Spur
15/01/01 – 18/01/01	L.E. *Eithne*	Irish Naval Service	Fisheries Patrol	Southwest shelf of Ireland
05/02/01 – 13/02/01	L.E. *Eithne*	Irish Naval Service	Fisheries Patrol	West shelf of Ireland
31/03/01 – 08/04/01	R.R.S. *Discovery*	Southampton Oceanographic Centre	Equipment Trials	Porcupine Seabight
17/03/01 – 06/04/01	*Walther Herwig III*	Institute of Sea Fisheries, Hamburg	Fish Egg Survey	Continental Slope
30/04/01 – 07/06/01	S.V. *Bligh*	Geological Survey of Ireland	Multibeam/ S-S Sonar	Rockall Trough
03/05/01 – 10/05/01	R.V. *Belgica*	University of Gent	Seismic Survey, Box Coring	Goban Spur / Porcupine Seabight
24/05/01 – 14/06/01	R.V. *G.O. Sars*	Institute of Marine Research, Bergen	Fish Egg Survey	Continental Slope
04/06/01 – 08/06/01	L.E. *Roisin*	Irish Naval Service	Fisheries Patrol	South & East Coasts
19/06/01 – 28/06/01	F.R.S. *Scotia*	FRS, Aberdeen	Fish Egg Survey	Continental Slope
30/06/01 – 03/07/01	S.V. *Siren*	Geological Survey of Ireland	Multibeam/ S-S Sonar	Porcupine Seabight
16/07/01 – 18/07/01	L.E. *Eithne*	Irish Naval Service	Fisheries Patrol	Continental Shelf
07/08/01 – 21/08/01	R.R.S. *James Clark Ross*	British Geological Survey, Edinburgh	Sediment/Bedrock Coring	Rockall Bank / Rockall Trough
16/08/01 – 03/09/01	R.R.S. *Discovery*	Southampton Oceanographic Centre	Fishing Trials	Goban Spur / Porcupine Seabight
02/09/01 – 04/09/01	F.R.S. *Scotia*	FRS, Aberdeen	Trawling Survey	Rockall Bank
11/09/01 – 12/09/01	L.E. *Niamh*	Irish Naval Service	Fisheries Patrol	West shelf of Ireland

Appendix B: Seabird species recorded during full surveys, July 1999– September 2001.

Common Name	Latin Name	Uncorrected Total
Northern Fulmar	*Fulmarus glacialis*	33,607
Soft-plumaged Petrel	*Pterodroma sp.*	1
Cory's Shearwater	*Calonectris diomedea*	21
Great Shearwater	*Puffinus gravis*	5,979
Sooty Shearwater	*Puffinus griseus*	1,710
Manx Shearwater	*Puffinus puffinus*	9,277
Mediterranean Shearwater	*Puffinus mauretanicus*	4
Wilson's Storm-petrel	*Oceanites oceanicus*	55
European Storm-petrel	*Hydrobates pelagicus*	1,699
Leach's Storm-petrel	*Oceanodroma leucorhoa*	86
Northern Gannet	*Morus bassanus*	22,360
Pomarine Skua	*Stercorarius pomarinus*	69
Arctic Skua	*Stercorarius parasiticus*	88
Long-tailed Skua	*Stercorarius longicaudus*	27
Great Skua	*Stercorarius skua*	832
Mediterranean Gull	*Larus melanocephalus*	3
Little Gull	*Larus minutus*	126
Sabine's Gull	*Larus sabini*	12
Black-headed Gull	*Larus ridibundus*	5,008
Mew Gull	*Larus canus*	1,177
Lesser Black-backed Gull	*Larus fuscus*	4,340
Herring Gull	*Larus argentatus*	417
Yellow-legged Gull	*Larus argentatus cachinnans*	11
Iceland Gull	*Larus glaucoides*	3
Great Blacked-backed Gull	*Larus marinus*	1,514
Black-legged Kittiwake	*Rissa tridactyla*	12,373
Sandwich Tern	*Sterna sandvicensis*	2
Roseate Tern	*Sterna dougalli*	3
Common Tern	*Sterna hirundo*	50
Arctic Tern	*Sterna paradisaea*	120
Little Tern	*Sterna albifrons*	2
Common Guillemot	*Uria aalge*	6,086
Brünnich's Guillemot	*Uria lomvia*	2
Razorbill	*Alca torda*	1,458
Black Guillemot	*Cepphus grylle*	10
Little Auk	*Alle alle*	14
Atlantic Puffin	*Fratercula arctica*	1,700

Appendix C: Coastal/inshore waterbird species recorded during full surveys, July 1999–September 2001.

Common Name	Latin Name	Uncorrected Total
Red-throated Diver	*Gavia stellata*	1
Great Northern Diver	*Gavia immer*	16
Red-necked Grebe	*Podiceps grisegena*	45
Great Cormorant	*Phalacrocorax carbo*	158
European Shag	*Phalacrocorax aristotelis*	112
Whooper Swan	*Cygnus cygnus*	1
Greylag Goose	*Anser anser*	349
Shelduck	*Tadorna tadorna*	4
Black Scoter	*Melanitta nigra*	35
Eurasian Oystercatcher	*Haemtopus ostralegus*	2
Ringed Plover	*Charadrius hiaticula*	3
Golden Plover	*Pluvialis apricaria*	1
Grey Plover	*Pluvialis squatarola*	2
Red Knot	*Calidris canutus*	1
Sanderling	*Calidris alba*	4
Dunlin	*Calidris alpina*	6
Whimbrel	*Numenius phaeopus*	25
Eurasian Curlew	*Numenius arquata*	10
Ruddy Turnstone	*Arenaria interpres*	5
Grey Phalarope	*Phalaropus fulicarius*	4

Appendix D: Terrestrial bird species recorded during full surveys, July 1999–September 2001.

Common Name	Latin Name	Uncorrected Total
Black Stork	*Ciconia nigra*	1
White Stork	*Ciconia ciconia*	1
Merlin	*Falco columbarius*	2
Hobby	*Falco subbuteo*	1
Eleonora's Falcon	*Falco eleonorae*	2
Rock Dove	*Columba livia*	6
Woodpigeon	*Columba palumbus*	2
Collared Dove	*Streptopelia decaocto*	1
Turtle Dove	*Streptopelia turtur*	2
Swift	*Apus apus*	3
Barn Swallow	*Hirundo rustica*	23
House Martin	*Delichon urbica*	12
Meadow Pipit	*Anthus pratensis*	2
Black Redstart	*Phoenicurus ochruros*	2
Wheatear	*Oenanthe isabellina*	3